ANALYSIS OF POLLUTION HAVEN HYPOTHESIS (PHH) AND ENVIRONMENTAL KUZNETS CURVE (EKC) IN SELECTED ASSOCIATION OF SOUTH EAST ASIAN NATIONS (ASEAN) COUNTRIES

FOZIA LATIF GILL

DOCTOR OF PHILOSOPHY
UNIVERSITI UTARA MALAYSIA
JUNE 2018

ANALYSIS OF POLLUTION HAVEN HYPOTHESIS (PHH) AND ENVIRONMENTAL KUZNETS CURVE (EKC) IN SELECTED ASSOCIATION OF SOUTH EAST ASIAN NATIONS (ASEAN) COUNTRIES

By

FOZIA LATIF GILL

Thesis Submitted to
Othman Yeop Abdullah Graduate School of Business,
Universiti Utara Malaysia,
In Fulfillment of the Requirement for the Degree of Doctor of Philosophy

Kolej Perniagaan
(College of Business)
Universiti Utara Malaysia

PERAKUAN KERJA TESIS / DISERTASI
(Certification of thesis / dissertation)

Kami, yang bertandatangan, memperakukan bahawa
(We, the undersigned, certify that)

FOZIA LATIF GILL

calon untuk Ijazah *(candidate for the degree of)* DOCTOR OF PHILOSOPHY (INDUSTRIAL & DEVELOPMENT ACADEMIC)

telah mengemukakan tesis / disertasi yang bertajuk:
(has presented his/her thesis / dissertation of the following title):

ANALYSIS OF POLLUTION HAVEN HYPOTHESIS (PHH) USING ENVIRONMENTAL KUZNETS CURVE (EKC) IN SELECTED ASSOCIATION OF SOUTH EAST ASIAN NATIONS (ASEAN) COUNTRIES

seperti yang tercatat di muka surat tajuk dan kulit tesis / disertasi.
(as it appears on the title page and front cover of the thesis / dissertation).

Bahawa tesis/disertasi tersebut boleh diterima dari segi bentuk serta kandungan dan meliputi bidang ilmu dengan memuaskan, sebagaimana yang ditunjukkan oleh calon dalam ujian lisan yang diadakan pada: **4 Jun 2018.** *(That the said thesis/dissertation is acceptable in form and content and displays a satisfactory knowledge of the field of study as demonstrated by the candidate through an oral examination held on:* ***4 June 2018****).*

Pengerusi Viva *(Chairman for Viva)*	: **Prof. Dr. Wan Nordin Wan Hussin**	Tandatangan *(Signature)*	
Pemeriksa Luar *(External Examiner)*	: **Prof. Dr. Khalid Abdul Rahim**	Tandatangan *(Signature)*	
Pemeriksa *Dalam* *(Internal Examiner)*	: **Prof. Dr. Roslan Abdul Hakim**	Tandatangan *(Signature)*	

Tarikh: **4 Jun 2018**
(Date)

Nama Pelajar (Name of Student)	:	**Fozia Latif Gill**
Tajuk Tesis / Disertasi *(Title of the Thesis / Dissertation)*	:	**Analysis of Pollution Haven Hypothesis (PHH) Using Environmental Kuznets Curve (EKC) In Selected Association of South East Asian Nations (ASEAN) Countries**
Program Pengajian *(Programme of Study)*	:	**Doctor Of Philosophy (Industrial & Development Economics)**
Nama Penyelia/Penyelia-penyelia *(Name of Supervisor/Supervisors)*	:	**Prof. Dr. K Kuperan Viswanathan**
		Tandatangan
Nama Penyelia/Penyelia-penyelia *(Name of Supervisor/Supervisors)*	:	**Prof. Dr. Mohd Zaini Abd Karim**
		Tandatangan

PERMISSION TO USE

In presenting this thesis in fulfilment of the requirements for a Post Graduate degree from the Universiti Utara Malaysia (UUM), I agree that the Library of this university may make it freely available for inspection. I further agree that permission for copying this thesis in any manner, in whole or in part, for scholarly purposes may be granted by my supervisor(s) or in their absence, by the Dean of Othman Yeop Abdullah Graduate School of Business where I did my thesis. It is understood that any copying or publication or use of this thesis or parts of it for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to the UUM in any scholarly use which may be made of any material in my thesis.
Request for permission to copy or to make other use of materials in this thesis in whole or in part should be addressed to:

Dean of Othman Yeop Abdullah Graduate School of Business
Universiti Utara Malaysia
06010 UUM Sintok
Kedah Darul Aman

ABSTRACT

The Pollution Haven Hypothesis (PHH) claims that because of international trade, developing countries have been specializing and exporting pollution-intensive goods to advanced countries. This study examines the PHH claim for trade between the six Association of South East Asian Nations (ASEAN) countries and two advanced countries (the USA, Japan) in Environmental Kuznets Curve (EKC) framework for the period 1989-2014. The Fully Modified Ordinary Least Square (FMLOS) panel co-integration approach has been employed to estimate the coefficients of the EKC model. The results reveal that the EKC does exist in the ASEAN countries and Singapore is the only country that has crossed the peak turning point income level of the EKC. This result implies that economic growth without any environment policy brings more CO_2 emission in the ASEAN region. When the effect of exports of pollution-intensive goods is controlled, turning point of the EKC arrives earlier. It implies that production and export of pollution-intensive goods has increased the environmental cost of economic growth in the ASEAN countries. The conclusion remains same in the model where exports of pollution-intensive goods are taken as an interaction term with income. The positive significant coefficients on FDI in all models indicate that FDI also contributes to the increase in CO_2 emissions. It is therefore, concluded that world pollution cannot be curtailed unless advanced countries reduce the consumption of pollution-intensive goods. It is a necessary condition for the existence of the world EKC that income elasticity for the demand of pollution-intensive products must fall as income increases. Changes in technologies and taste and preferences of consumers in developed world are required to reduce global pollution. An integrated well devised global programme is imperative to tackle the alarming issue of the global warming and advanced countries should lead this programme.

Keywords: pollution haven hypothesis, CO_2 emissions, environmental Kuznets curve, pollution-intensive goods, ASEAN, FMOLS

ABSTRAK

Hipotesis Pencemaran *Haven* (PHH) mendakwa bahawa perdagangan antarabangsa mendorong negara-negara membangun mengkhusus dan mengeksport barangan intensif-pencemaran ke negara-negara maju. Kajian ini meneliti dakwaan PHH dalam kerangka Keluk Alam Sekitar Kuznets (EKC) untuk perdagangan enam negara Persatuan Negara Negara Asia Tenggara(ASEAN) dan negara maju (Amerika Syarikat, Jepun) bagi tempoh 1989-2014. Kaedah integrasi panel *Fully Modified Ordinary Least Square* (FMLOS) telah digunakan untuk membuat anggaran kecekapan bersama model tersebut. Menurut hasil kajian, EKC tidak wujud dalam negara ASEAN dan Singapura merupakan satu-satunya negara yang melepasi tahap pendapatan EKC. Keadaan ini menandakan pertumbuhan ekonomi tanpa sebarang ukuran dasar akan mendatangkan lebih banyak pelepasan Gas Rumah Hijau (GHG) dalam negara negara ASEAN. Apabila kesan eksport bahan pencemaran intensif dikawal, titik perubahan EKC akan tiba lebih awal. Hal ini menandakan pengeluaran dan eksport barangan intensif-pencemaran telah melambatkan titik perubahan EKC dan meningkatkan kos pertumbuhan ekonomi alam sekitar. Kesimpulannya kekal sama dalam model di mana pengeksportan barangan intensif-pencemaran diambil secara interaktif dengan pendapatan. Koefisien positif yang signifikan terhadap FDI dalam semua model menunjukkan FDI juga menyumbang kepada pelepasan GHG. Hasil yang sama dilihat dalam kes pengeksportan barangan intensif-pencemaran ke Amerika Syarikat. Oleh yang demikian, dapat disimpulkan bahawa pencemaran dunia tidak dapat dikurangkan melainkan negara-negara maju mengurangkan tahap penggunaan yang tinggi. Dunia perlu peka dengan kewujudan EKC bahawa keanjalan pendapatan terhadap permintaan produk intensif-pencemaran perlu menurun apabila terdapat peningkatan pendapatan. Perubahan beban bukanlah penyelesaian. Sebuah program global bersepadu yang baik diperlukan untuk menangani masalah pemanasan global dan negera-negara maju harus memimpin program tersebut.

Kata kunci: Hipotesis Pencemaran Haven, pengeluaran CO_2, Keluk Alam Sekitar Kuznets, barangan intensif-pencemaran, ASEAN, FMOLS

ACKNOWLEDGMENT

In the name of Allah, the most kind and merciful. O "Allah let your blessings come upon Muhammad (PBUH) and his family ever and ever". Truly you are praiseworthy and glorious ameen. I thank my Allah almighty for his countless blessings Alhamdulillah.

First, it is my privilege to express my deepest gratitude to my advisors Prof. K Kuperan Viswanathan and Prof. Mohd Zaini Abdul Karim for the continuous support of my PhD study and related research, for their patience, motivation and immense knowledge. Their guidance helped me all the time of research and writing of this thesis. I could not have imagined having a better advisors and mentors for my PhD study.

Besides my advisors, I would like to thank the rest of my thesis committee: Prof. Roslan Abdul Hakim, Prof. Jamal and Prof. Khalid for their insightful comments and encouragement and also for the hard questions that incanted me to widen my research from various perspectives.

I would love to acknowledge my father Mohamad Latif Nasim and mother Mumtaz Akthar for their encouragement and support throughout the thesis. I would also pay my heartfelt appreciation and acknowledgement to my beloved husband Dr. Abid Rashid, and my adorable daughters Momina and Fatima for their spiritual sport, understanding and patience throughout this journey. Last but not the least, my sincere thanks to my siblings Razzaq Gill, Mohsin Latif Gill, Humaira, Sumaira, Sobia and Sania for their prayers and love. Also special thanks to OYA for providing me with congenial environment for learning and writing this thesis.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE

INTRODUCTION

The first Chapter has 15 sections. Section 1.1 states the background of the Pollution Haven Hypothesis (PHH) and Section 1.2 describes some examples of the PHH. Section 1.3 explains the difference between the PHH and the Pollution Haven Effect while, Section 1.4 reveals arguments against the PHH. Section 1.5 describes the Environmental Kuznets Curve(EKC) and the PHH. Section 1.6 and 1.7 explains the trade and environment situation in the Association of South East Asian (ASEAN) countries and section 1.8 details the problem statement. The general and specific research questions have been described in Section 1.9 and Section 1.10 respectively. Section 1.11 describes the general objectives of the study while, Section 1.12 describes the key objectives of the study. Contribution of the study has been detailed in section 1.13. The scope of the study has been described in Section 1.14 and Section 1.15 finally concludes the significance of the study. Lastly, Section 1.16 concludes the chapter.

1.1 Background of the Pollution Haven Hypothesis (PHH)

Since 1970s, the issues related to international trade and environment have been extensively debated. The impact of international trade on environment and environment on international trade have been the focus of the debate. This debate started in 1970's and became intense in 1990's when trade openness was expanded by different organizations like North American Free Trade Agreement (NAFTA), United Nations Conference on Environment and Development (UNCED), Uruguay Round of the General Agreement on Tariffs and Trade (GATT) and World Trade Organization (WTO). The trade agreements in the 1990s like NAFTA, UNCED and GATT included environment considerations in their main documents. The Environmental

Review of Trade Agreements (1999) of the USA also included environmental considerations in its trade negations.

The worldwide distribution of industrial pollution then became an important subject in the literature of environmental economics. The economists, the researchers, the industrial and political groups become worried about the impact of international trade on the environment Ederington (2007); (Stonehouse, 2000). Two contradictory views emerged that time about trade and environment link and offered opposite theoretical explanation with the same dynamics. The one extreme was the Pollution Haven Hypothesis (PHH) and other was the Porter Hypothesis (PH).

The Porter hypothesis by (Porter & Van der Linde, 1995) argued that most stringent environmental regulations in home country induce the induction of more clean and efficient technologies. These clean and efficient technologies reduce the marginal cost and raise the productivity of the firms resultantly, the firms become more competitive.

While, the PHH was first postulated by Copeland and Taylor (1994) in the context of North-South trade under NAFTA. It was the first research study that links the environmental regulation stringency and trade patterns with the level of pollution in a country. Under NAFTA the firms operating in highly regulated countries like the USA and Canada came in direct competition with the firms operating in poor countries that have lax environmental standards like Mexico. Copeland and Taylor (1994) predicted that NAFTA would become an environmental disaster for Mexico and job disaster for the USA. They further submitted that under the trade liberalization, the firms that produce pollution-intensive goods[1] would move

[1] These are the goods that have most pollution- intensive production process.

from rich countries that have strict environmental regulations to those developing countries that have comparatively weak environmental regulations. Therefore, in open and liberalized trade, the developing countries would become pollution haven for the pollution-intensive industries of the advanced countries. The PHH predicted an environmental disaster in developing countries that would specialize and export pollution-intensive goods in free trade regime.

According to the PHH, the differences in environmental regulations between developing and developed countries cause the developing countries to specialize in the most pollution-intensive industries. The price of environmental resources[2] in the developing countries is far lower than the developed countries. Resultantly, they possess a comparative advantage in the production of most pollution-intensive industries. The developing countries therefore, tend to specialize, and export pollution-intensive goods while, developed countries tend to specialize and export clean goods[3]. Consequently, the developing countries have become the pollution haven for the pollution intensive industries of the advanced countries. The PHH supports the believe that developed countries are on the downward slope of the EKC because they have exported the pollution-intensive production process to developing countries.

The PHH implies that free trade would lead the pollution-intensive production process to poor developing countries. Moreover, it also implies the unrestricted extraction of natural resources

[2] "Environmental resources can be defined as elements of the human environment and include both natural and built resources. Three major categories of resources are socioeconomic, cultural and natural. Socioeconomic Resources refer to people, homes, communities, farms and farmland, community facilities (parks, recreation areas, emergency services, educational and religious facilities, cemeteries; water and sewer services), businesses, jobs, and economic conditions. Cultural Resources are historic properties or archaeological sites that have a significant place in history. These include buildings, structures (bridges, dams, towers), sites (battlegrounds, landscapes, archaeological sites), objects (fountains, monuments, signs) or districts, generally 50 years old or older, that are eligible for or listed on the National Register of Historic Places. Natural resources include all of the elements of the natural environment: geology, topography, and soils; groundwater, streams, rivers, lakes, ponds, wetlands and floodplains; vegetation and wildlife; rare, threatened and endangered species; and other sensitive resources".

[3] That have clean production process. Like service sector, and high-tech industry

from developing countries by the Multinational Corporations (MNCs). These MNCs are mostly engaged in the production of timber, petroleum products and some other forests resources (Aliyu, 2005).

The critics of trade liberalization also submitted that weak environment standards had been the major cause of the concentration of pollution-intensive industries in developing countries. They further claimed that the consumers of developed world had been enjoying the pollution-intensive goods at lower prices owing to the under-pricing of environmental resources in developing countries. Asghari and Mohamadi (2016) explained three underlying reasons of the specialization of the developing countries in pollution-intensive goods. First, the cost of monitoring the environmental regulations and standards is relatively high in developing countries as compare to advanced countries. This is because developing countries lack institutional frame-work, technical skills and clearly defined property rights about the environmental resources that are the prerequisite of effective environmental governance.

Secondly, as environment being a normal good is demanded at higher income level therefore, developed countries with higher income level have larger demand of environmental goods like clean water and clean air. While developing countries with low-income focus on income and employment generation. Finally, growth in developed countries implies a shift from manufacturing to services and to high tech sectors that result in low pollution intensity. While, growth in developing countries implies a shift from agriculture to industrialization and to urbanization. It leads to huge investment in urban infrastructure and high pollution intensity.

Since, 1990s the PHH has become the centre of the debate on the environmental impact of international trade (Taylor, 2004). This debate has become increasingly important as global production chain has reshaped the patterns of international trade. The empirical support to the PHH is mixed as (Jaffe et al., 1995; Tobey, 1990) did not find any evidence to claim that stringency of environmental regulation of a country had any impact on the trade of pollution-intensive goods. On the contrary, Mani and Wheeler (1998) found a temporary evidence in favour of the PHH. Cole (2004) also found that pollution-intensive industries grew at rapid speed in developing countries in the periods when environmental regulations in the OECD countries had been very stringent. Similarly, Frankel and Rose (2005a) also found a support for the PHH from a city-level study of SO_2 concentrations similarly, Cole and Elliott (2005) also supported these results.

1.2 Some Examples of the PHH

Some research studies also provided empirical examples of the PHH hypothesis. As Shui and Harriss (2006) noted that embodied carbon emission in the exports of China to the USA has increased from 213 million tons in 1997 to 497 million tons in 2003. Davis and Caldeira (2010) calculated consumption-based global CO_2 emission. They found that 23 per cent of global CO_2 emission in 2004 was internationally traded. This was mainly due to the export of primary and secondary goods from emerging markets to developed countries. They further revealed that 30 per cent of consumption-based CO_2 emissions in these developed countries were from imported goods. They also calculated that net import of CO_2 emission of many European countries is around 4 tons CO_2 emission per person in 2004.

Du et al. (2011) also found that embodied CO_2 emission in the export of China to the USA has increased from 408.49 million tons in 2002 to 812.01 million tons in 2007. Similarly, Peters et al. (2011) developed a trade-related global CO_2 emissions database for 57 sectors and 113 countries. They also found that CO_2 emissions in advanced countries have stabilized for the period 1990 to 2008 while in the same period CO_2 emissions in developing countries have doubled. CO_2 emissions from internationally traded goods have increased 20 to 26 per cent of global CO_2 emissions in the same period and consumption-based emission in developed countries also have increased. The net emission transfer via traded goods from developing to developed countries has increased from 0.4 Gt CO_2 in 1990 to 1.6 in 2008.

According to Lin et al. (2014) "36% of anthropogenic sulphur dioxide, 27% of nitrogen oxides, 22% of carbon monoxide and 17% of the black carbon emitted in China were associated with the production of goods for foreign consumers. For each of these pollutants, about 21% of export-related Chinese emissions were attributed to China-to-US export".

Kanemoto et al. (2014) also concluded that consumption of pollution-intensive goods should be curbed especially in advanced countries. From the analysis of 187 countries for the period 1970 to 2012, they found that international trade has undermined the emissions control targets set by individual countries. Moreover, they also highlighted that despite the aggressive legislation in advanced countries the global pollution is still on the rise because these countries have shifted the burden.

Moreover, by examining the global nitrogen footprint in 188 countries Oita et al. (2016) found that 25 per cent of global nitrogen footprint was from the internationally traded commodities. The exporters of these commodities have been from developing countries whereas, net importers of these commodities have been developed countries. Oita et al. (2016), therefore, concluded that nitrogen pollution in developing countries has been primarily driven by the demand of these products from wealthy countries.

Zhao et al. (2016) investigated the main driving factors behind the embodied CO_2 emission in US-China trade using the time 1995 to 2009. The results showed that export share of final product and foreign demand were the main driving factors. The sectoral level analysis revealed that machinery, textile products and transport and electrical equipment that are exported to the USA were the main contributors of the local pollution.

O'Sullivan (2017) also reported that globalization of goods and services have shifted the harmful effects of some production activities from consuming societies to producing societies. He cited the example of the toy industry. Toys that are sold in the USA and Western Europe are manufactured in China, displacing the pollution that otherwise has been released in Western Europe and the USA. He therefore, claimed that advanced nations have been effectively outsourcing the environmental damages that come from the production of such type of products. Furthermore, Zhang et al. (2017) stated that 762400 worldwide deaths were linked to the consumption of goods and services that were produced in another region. They further highlighted that high mass consumption in the USA and the Western Europe were related to 108600 premature deaths in the China.

In addition, Maclean (2017) reported that t world's chocolate industry is driving deforestation on a devastating scale in West Africa. The Cocoa traders who sell coca to Mars, Nestlé, Mondelez and other big brands buy beans grown illegally inside protected areas in the Ivory Coast, where rainforest cover has been reduced by more than 80% since 1960. Up to 70% of the world's cocoa is produced by 2 million farmers in a belt that stretches from Sierra Leone to Cameroon, however, Ivory Coast and Ghana are the giants, the world's first and second biggest producers. They are also the biggest victims of deforestation. Ivory Coast is losing its forests at a faster rate than any other African country less than 4% of the country is covered in rainforest once, it was one quarter. The ballooning global demand for chocolate means that if nothing is done, by 2030 there will be no tropical forest left in Africa.

".

Randerson (2017) reported a report by Prof Richard Norgaard (an ecological economist at the University of California, Berkeley) that is the systematic analysis of the ecological damages caused by rich countries to developing countries. According to the report, "The environmental damage caused to developing nations by the world's richest countries amounts to more than the entire third world debt of $1.8 trillion. The study found that there are huge disparities in the ecological footprint[4] inflicted by rich and poor countries on the rest of the world because of differences in consumption. The authors say that the west's high living standards are maintained in part through the huge unrecognised ecological debts[5] it has built up with developing countries".

1.3 Difference Between the PHH and the Pollution Haven effect

The pollution haven effect predicts that foreign direct investment (FDI) responds to environmental regulation by moving from the countries with stringent regulations to those countries that have lax environmental regulations. Previous literature has sometimes failed to adequately distinguish between the pollution haven hypothesis and the pollution haven effect

[4] "The ecological footprint is a resource accounting tool that measures how much biologically productive land and sea is used by a given population or activity and compares this to how much land and sea is available. Productive land and sea areas support human demands for food, fibre, timber, energy, and space for infrastructure. These areas also absorb the waste products from the human economy. The Ecological Footprint measures the sum of these areas, wherever they physically occur on the planet. The Ecological Footprint is used widely as a management and communication tool by governments, businesses, educational institutions, and non-governmental organizations".

[5] "Ecological debt is the level of resource consumption and waste discharge by a population in excess of locally sustainable natural production and capacity. The term has been used since 1992 by some environmental organizations from the South. It refers to the environmental liabilities of Northern countries for the excessive per capita production of greenhouse gases, the ecological debt is manifested in the destruction of the environment and associated climate change that North has created and has made possible through the process of modernization and capitalism".

(Taylor, 2004). The pollution haven hypothesis predicts that removal of trade barriers between high-income and low-income countries results in pollution-intensive production moving to low-income countries with relatively lax environmental regulation. A necessary condition for the pollution haven hypothesis is a strong pollution haven effect. The pollution haven effect may be triggered by changes in either home country or host country regulation. Existing literature focuses on the host country effects, while the effect of home country environmental regulation on FDI has been virtually ignored.

1.4 Arguments against the PHH

Nevertheless, Dinda (2004) rejected the PHH stance. He submitted that the polluting industries that tend to locate in the developing countries, would also raise the income levels of the host country. Resultantly, these host countries would also start imposing the stringent environmental regulations. Therefore, sooner or later there would be no country where polluting industries can be relocated and all countries would be on same playing level. Furthermore, there are also other arguments against the theory, assumptions and implications of the PHH. These arguments are as follows;

a) It is argued that firms while shifting to a country that has lax environmental regulations, also consider that pollution reduces the productivity of the labour force that may raise the labour cost of the firm.
b) Second, the firms also consider the huge sunk cost[6] when they decide to shift the production operation to another country.
c) Third, the countries with lax environmental regulations, usually have a weak legal system and ill-defined commercial laws. Whereas, the investors from developed

[6] In economics and business, a sunk cost is a cost that has already been incurred and cannot be recovered.

countries prefer the countries that have clear regulations and effective enforcement of laws. Therefore, they are likely to avoid investing in those countries that have lax environmental regulations.

d) Fourth, It is also argued that trade and investment flows are driven by the factor endowment, especially those that flow from North to South[7] (Ethier, 1982; Helpman, 1984; Markusen, 1984). The factor endowment theory states that capital abundant countries should specialize and export capital-intensive goods while, labour abundant countries should specialize and export labour-intensive goods. Nevertheless, the capital-intensive sector is considered a typical pollution intensive sector and capital abundant countries are those that have most stringent environmental regulations. Therefore, capital-labour Hypothesis (KLH) seems to produce the trade and investment patterns that are opposite to the PHH. The KLH implies that capital abundant North will specialize and export capital-intensive goods that are also pollution- intensive and labour abundant South will specialize and export labour-intensive goods that are less pollution-intensive.

e) Fifth, The Porter hypothesis by (Porter & Van der Linde, 1995) is another argument against the PHH. As stated in this hypothesis, most stringent environmental regulations in home country induce the induction of more clean and efficient technologies. These clean and efficient technologies reduce the marginal cost and raise the productivity of the firms resultantly, the firms become more competitive.

f) Sixth, According to Letchumanan and Kodama (2000), most of the work on the PHH is rooted in neoclassical theory of comparative advantage that treats the environment as

[7] "The North–South divide is broadly considered a socio-economic and political divide. Generally, definitions of the Global North include the United States, Canada, Western Europe, and developed parts of Asia, as well as Australia and New Zealand, which are not actually located in the Northern Hemisphere but share similar economic and cultural characteristics as other northern countries. The Global South is made up of Africa, Latin America, and developing Asia including the Middle East".

another factor that entails comparative cost advantage. The neoclassical theory of comparative advantage does not consider dynamic factors such as innovation, technology, market access and strategic partnership that exert a more significant effect on the competitiveness of the export than the comparative cost advantages factors. There are very few empirical studies that have been based on these dynamic factors. He also criticised the assumption of the PHH that industries are perfectly mobile to take locational advantages of pollution haven.

g) Seventh, many analysts have largely ignored the present motivational factors for transboundary movement of industries through FDI. Locational comparative advantage factors are becoming increasingly insignificant in the current highly competitive market. Factors such as market penetration and strategic alliances in technology development and management are becoming more important than factors such as cheap labour and capital in current investment decisions to maintain long-term competitiveness. The World Investment Report 2009 maintains that TNCs [8] are increasingly establishing 'integrated international production systems' in the current export-orientated free trade regime by capitalizing on efficiency gains through technological innovation. Thus, most empirical studies which rely primarily on neo-classical comparative advantage trade theory in examining the 'pollution-haven' hypothesis suffer from a lack of pragmatic and convincing conceptual framework.

h) Finally, the Green Haven Hypothesis (GHH) states that capital and pollution-intensive industries are also concerned with their corporate social responsibility (CSR). They also follow the triple bottom line (people, profit, and the planet) and maintain their green

[8] "Transnational Corporations (TNCs) are also o known as MNCs (Multinational Companies) these are large businesses that operate in a number of countries. They often separate their production between various locations, or have their different divisions head office and administration, research and development, production, assembly, sales separated around a continent or the globe".

reputation, therefore, contribute to minimize the ecological footprints (Herzig & Schaltegger, 2006; Willis, 2003). The GHH thus is contrast theory to the PHH.

These opposing arguments explain why empirical literature on the PHH has mixed outcome. Therefore, there has been a constant motivation for the researchers in environmental economics to search empirical evidence against or in the support of the PHH.

1.5 Environmental Kuznets Curve (EKC) and the PHH

The connection between environmental degradation and economic growth arose from the path-breaking studies of Grossman and Krueger (1991); (Panayotou, 1995; Shafik & Bandyopadhyay, 1992) known as Environmental Kuznets Curve (EKC). The EKC states a nonlinear inverted U-shape relationship between income and environment. According to this hypothesis economic growth is the cause as well as a remedy to the environmental problems of the world. Economic growth deteriorates the environment of a country at the early stages of economic development however, at the later stages of economic development economic growth generates the conditions that are conducive to the environmental problems of that country. According to the proponents of the EKC, the cities of developed countries like London and Tokyo were as polluted in the 50s and 60s as the cities of developing countries of the day. Figure 1.1 explains nonlinear relationship between economic growth and pollution.

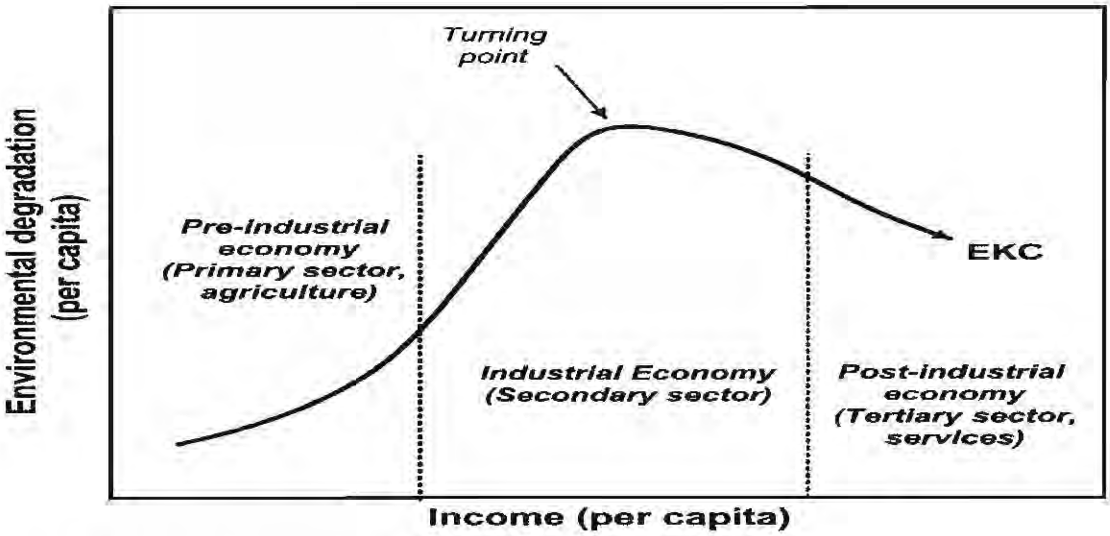

Figure 2.1: *The EKC relationships between income and environment*

Since 1990s, EKC hypothesis attracted the attention of the serious commentators of development economics and affected the policy and priorities of governments, organizations, and world development institutions. The empirical and theoretical literature on the EKC have a mixed outcome. A large body of the literature such as Ezzati et al. (2001), Raymond (2004), Aslanidis and Iranzo (2009)and Nicholas (2015) criticized the assumptions and theoretical basis of the EKC.

One of the main criticisms on Environmental Kuznets Curve (EKC) was that it did not consider the impact of changes in trade pattern on the environment of a country. According to several critics of the EKC such as Cole (2004), Stern (2004) and Nahman and Antrobus (2005), developing countries have lax environmental regulations as compared to advanced countries therefore, they have a comparative advantage in pollution-intensive industries. Resultantly, the pollution-intensive industries of rich countries that face stringent environmental regulations in rich countries, tend to migrate to the developing countries to take advantage of lax environmental regulation. This migration has decreased the pollution in developed countries as they start to import pollution-intensive goods from developing countries.

The downward slope of the EKC of developed countries may reflect this relocation of the polluting industries. Because of this relocation, the pollution in developed countries has decreased while the total pollution of the world has not come down. This phenomenon can also be called Pollution Haven Hypothesis (PHH). The PHH claims that difference in the stringency of environmental regulations between the developed and developing countries will provide the latter with a comparative advantage in pollution-intensive production. The developed countries may specialize in clean production and rely on the developing countries for the provision of pollution-intensive output. Then the EKC may not imply a net reduction in pollution, but simply a transfer of the pollution from rich countries to poor countries.

If the EKC does not exist and pollution continues to increase with further economic growth, unbridled economic growth would lead us to environmental constraint and to the "limit to growth" as recommended by Meadows (1972)[9]. He claimed that the economy of the world would reach to physical limits of growth very soon due to ecological damages of economic growth. If the PHH exists, it implies that the EKC exists only for individual countries and the EKC for the world economy does not hold. Therefore, it will be useful to analyze the specialization patterns of the industries in developing countries and to investigate the impact of their trade composition on the rising pollution in developing countries. Several studies like Atici (2012); (Azhar & Elliott, 2007; Beladi & Oladi, 2011; Cole & Elliott, 2003; Elliott & Shimamoto, 2008; Haisheng et al., 2005) investigated these links theoretically and empirically

[9] Meadows, Donella H. "Dennis I. Meadows, Jorgen Randers, William W. Behrens III.: THE LIMITS TO GROWTH. A Report to the Club of Rome." (1972)

and have mixed findings. The link between trade and the environment is discussed in the next section.

1.6 Trade and the Environment

The increasing trade is considered to help a country to realize fast economic growth. Nevertheless, this increased trade can also harm the environmental quality of that country. Although liberalized trade and investment policies lead to more economic activities and more wealth generation however, it also has several environmental effects. The interplay between trade and pollution has been securitized by many research studies.

Muradian and Martinez-Alier (2001) noted that neither ecological economics [10] nor environment economics fully encompassed the structural conditions that determine the trade flows between the countries and regions. Cole and Elliott (2003) found little evidence that trade pattern of a country can affect the EKC of that country. Similarly, Atici (2009) from the study of Eastern and Central European countries found that trade openness did not reduce the emission levels in the region.

The literature on environment and trade has developed over the years (Anderson et al., 1992; Cole, 2000; Esty, 1994, 2001). One school of thought claimed that trade liberalization would reduce pollution as it generates a competitive environment in a country to become more efficient in the utilization of environmental resources. Grossman and Krueger (1991) were the

[10] "Ecological Economics addresses the relationships between ecosystems and economic systems in the broadest sense. These relationships are the locus of many of our most pressing current problems (i.e. sustainability. acid rain. global warming, species extinction. wealth distribution) but they are not well covered by any existing discipline. Environmental and resource economics, as it is currently practiced, covers only the application of neoclassical economics to environmental and resource problems. Ecology, as it is currently practiced, sometimes deals with human impacts on ecosystems, but the more common tendency is to stick to "natural" systems. Ecological Economics aims to extend these modest areas of overlap. It will include neoclassical environmental economics and ecological impact studies as subsets but will also encourage new ways of thinking about the linkages between ecological and economic systems".

first who provided a systematic analysis of trade and environment relation. They broke down the impact of trade into scale, technique and composition effect. Due to increasing trade and increase in economic activities, scale effect generates pollution at the early stages of economic development. While, continuous increase in economic activities leads to technological growth and efficient resource usage at the later stages of economic development. Finally, it is the composition effect that leads a country to specialize in an industry where the country has a comparative advantage.

The composition effect is the most relevant for the PHH to affect the EKC transition. How composition effect affects the pollution in a country, depends on its source of comparative advantages and most importantly whether it has comparative advantages in pollution-intensive goods or not. He and Wang (2012) claimed that trade liberalization generally leads to increase in the economic activities and to more wealth generation. This accumulated wealth creates awareness about the environmental problems. International trade also transfers advanced and most energy efficient technologies from developed to developing countries. Therefore, developing countries with these modern clean technologies can clean production process following the international trade.

1.7 Trade and Environment in ASEAN Countries

The ASEAN countries have been following the policies of trade and investment liberalization for the last three decades and have enjoyed rapid economic growth. The increased international trade has played an important role to propel these countries towards the status of middle-income and high-income countries. Table 1.1 shows the share of the trade in total GDP of the ASEAN countries. Singapore and Malaysia have the highest trade to GDP ratios in the region. It indicates that they are the most open economies in term of trade and investment regulations.

Table 1.1
Trade as % of GDP of the ASEAN Region

	2011	2012	2013	2014	2015	2016
Brunei	87	87	83	81	81	81
Cambodia	125	137	142	145	148	149
Indonesia	50	50	49	48	42	44
Malaysia	155	148	143	138	134	136
Myanmar	33	33	41	43	45	46
Philippines	68	65	60	61	61	62
Singapore	377	367	362	360	326	325
Thailand	114	112	106	105	98	99
Vietnam	163	157	165	170	179	182

Source: *World Bank Focus Economics (2016)*

However, liberalized trade and economic growth also followed by several environmental problems in these nations. According to Fig. 1.2, there is momentous increase in CO_2 emission over the last three decades in the ASEAN region. The countries like Singapore, Malaysia, Indonesia, Thailand and Vietnam, have a significant increasing trend of carbon emission.

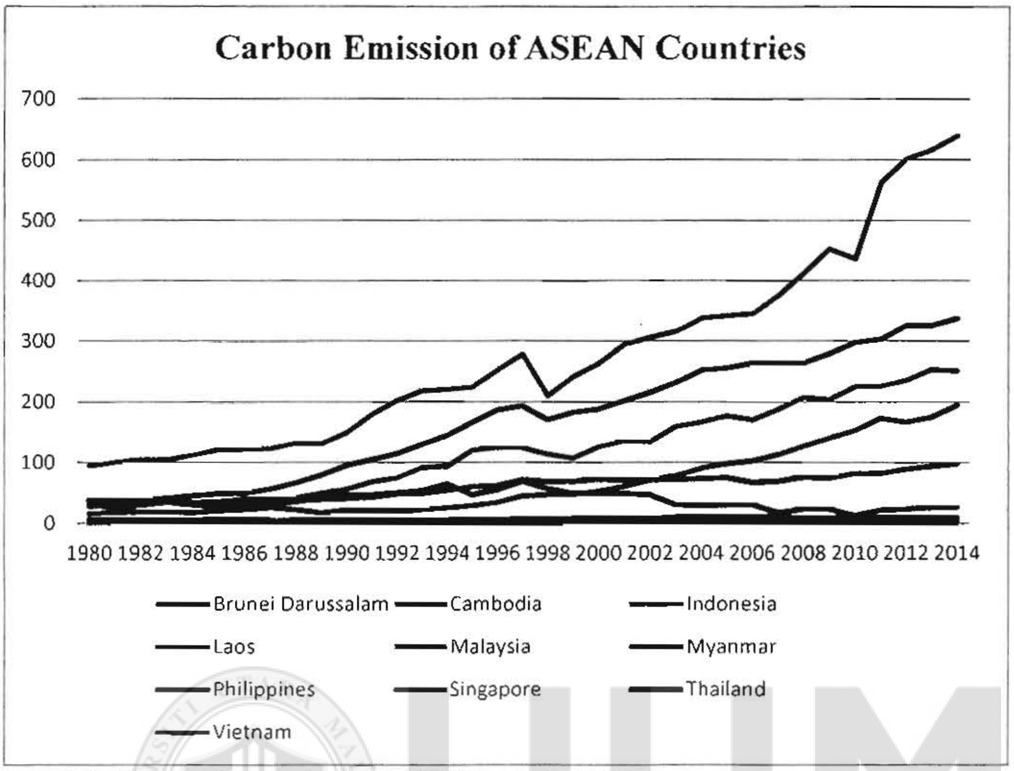

Figure 1.2: CO_2 emissions in the ASEAN, 1980–2014
Source: *World Bank, 2015*

1.8 Problem Statement

Environmental degradation problem is a global phenomenon and Association of South East Asian Nations (ASEAN) countries are not exemption to it. According to the ASEAN Environmental Report (2015), increased industrialization and urbanization in the 1990s and 2000s generated severe environmental problems like air pollution, water pollution and accumulation of urban wastes in the ASEAN countries. Although, the ASEAN countries have been relatively active in pursuing of environmental policies as compared to other regions by incepting programs for the conservation of nature and marine life with the collaboration of United Nations Environment Programme (UNEP). Moreover, the regional and bilateral cooperation also have been growing like Asia–Pacific Partnership on Clean Development and Climate (APP) and 10+3 (ASEAN + China, Japan, and Korea) for environmental protection (Kameyama et al., 2008).

However, according to Global Climate Risk Index (2016), the ASEAN countries are vulnerable to environment changes as these countries are island and are exposed to the risk of rising ocean level. In addition, the ASEAN countries also have deteriorated air quality in their cities as revealed by World Air Quality Index 2016. The deteriorated air quality has dangerous health repercussions in the ASEAN region. More importantly, according to the Environmental Performance Index 2016, that is considered comprehensive measure of environmental conditions of a country, the ASEAN countries especially Indonesia, Thailand, Vietnam, Laos, and Burma have alarming indicators of the environmental quality. Similarly, Fig. 1.2 in previous section indicates the momentous increase in CO_2 emission over the last three decades in the ASEAN region. The environmental degradation can be linked to the several factors such as trade, papulation growth, urbanization, transportation, energy consumption and FDI.

The ASEAN countries have been following the policies of trade and investment liberalization since 1980s. The trade has been an important tool for the ASEAN countries to achieve the targets of high economic growth and Japan and the USA have been the important trade partners. The ASEAN countries have the highest trade to GDP ratio as compared to the other regions of the world (World Bank, 2015). Therefore, it can be claimed that the ASEAN countries have been perusing an export-led growth strategy.

The East Asian countries also have been the major recipients of Foreign Direct Investment (FDI) since 1970s. After the 1970s, newly industrialised countries NICs (Korea, Taiwan, Hong Kong, Singapore) were the major recipient of FDI from Japan. However, as the cost of production including wages, land prices rose in these countries, the ASEAN four countries (Indonesia, Malaysia, Philippines and Thailand) emerged as another major recipient of FDI in the 1980s. Since 1990s, Vietnam and Thailand have attracted the investors from all over the world. The trade and investment liberalization policies led the ASEAN countries to the fast track of economic growth. However, this growth is also accompanied by several environmental problems as highlighted in the PHH.

The PHH claims that under the trade and investment liberalization, the firms that produce pollution-intensive goods would move from rich countries to developing countries to take advantages of cheap environmental resources. Therefore, in open and liberalized trade, the developing countries tend to specialize and export pollution-intensive goods for advanced countries. The PHH supports the believe that developed countries are on the downward slope of the EKC as they have exported the pollution-intensive production process to developing countries like ASEAN.

The ASEAN countries as main trade partner of advanced countries like Japan and the USA facing environmental problems tend to be a case to be investigated for the PHH trade patterns. The increasing trends of trade and pollution indicate that the ASEAN countries may have the PHH trade pattern. Prior studies on the relationship between trade and environment is scant in the context of ASEAN countries such as (Atici, 2012; Elliott & Shimamoto, 2008; Takeda & Matsuura, 2006). The studies that have investigated the issue using fresh datasets are few. For instance, (Atici, 2012) was the latest study that investigated the trade and environment link for 1970-2000 time period. This study however, looked at total trade impact on the environment and did not examine the impact of pollution-based export industries. Also, the studies did not analyse trade link between advanced countries and the ASEAN in the EKC framework. The studies also did not test the PHH claim that developing countries like the ASEAN have skewed EKC as they have become a pollution haven for the advanced countries. If this test had employed in the previous studies, results would have highlighted how much exports of pollution-intensive exports contributed to the environmental cost of economic growth in the ASEAN region.

1.9 General Research Question

The ASEAN countries have been following the policies of investment and trade liberalization for last three to four decades. They have witnessed a remarkable level of economic growth yet facing the problems of environmental degradation. Therefore, a question arises that the trade patterns have any impact on the environmental conditions of these countries? Whether pollution haven hypothesis (PHH) is relevant for these countries or to what extent the PHH is responsible for the skewed shape of the EKC in these countries?

1.10 Specific Research Question

- Do the exports of pollution-intensive goods of the ASEAN countries to advanced countries (USA, Japan) contribute to emission of the CO_2 emissions from the ASEAN countries?
- Are the specialization and export of pollution-intensive goods responsible for the delayed turning point of the EKC in the ASEAN countries?
- Do the FDI inflows to the ASEAN countries contribute to CO_2 in the region?

1.11 General Objectives of the study

Among the general objectives of the current study is to examine the theoretical and empirical bases of the PHH in the EKC framework. The ASEAN countries have been following the policies of investment and trade liberalization for the last three to four decades. Therefore, the study investigates the extent to which trade and investment have increased the environment cost of economic growth in the ASEAN region.

1.12 Specific objectives of the study

- To examine the impact of exports of pollution-intensive goods of the ASEAN countries to advanced countries (USA, Japan) on the emission of the CO_2 emissions from the ASEAN countries.
- To investigate whether specialization and export of pollution-intensive goods are responsible for the delayed turning point of the EKC in the ASEAN countries.
- To examine the impact of FDI inflows to the ASEAN countries on the CO_2 in the region.

1.13 Contribution of the Study

The previous literature reveals scarcity of the empirical studies pertinent to investigation of the PHH trade patterns of the ASEAN countries in the context of the EKC framework. This study therefore, would be a significant contribution to the trade and environment literature. Current research tends to provide a fresh look at the environmental issues of the ASEAN countries in the context of the PHH trade patterns. There is a need to test the PHH in the context of the ASEAN countries to examine how much specialization and export of pollution-intensive goods have increased the environmental cost of economic growth. The gap in knowledge about the existence of the PHH can be reduced through this study.

1.14 Scope of the Study

This study investigates the possible effect of trade of pollution-intensive goods on environmental pollution in the ASEAN countries with developed countries (USA, Japan) in the context of the EKC. The study uses panel data of six ASEAN countries for the period of

1989 to 2014. The pollution-intensive goods include those goods that have the most polluted production process. In the context of this study, chemical, paper and pulp, plastic and wood industries are analysed. These are the industries that generate the most carbon emission in production process.

1.15 Significance of the Study

This study has significant theoretical and practical implications. The PHH is a major criticism on the EKC. If the PHH exists, it implies that pollution of the world will not be reduced with continuous economic growth as claimed in the EKC relationship. Developing countries of day after becoming rich will search other places in the future to relocate these dirty industries. Given the fixed supply of the world environmental resources, the fast-economic growth of developing countries of day may lead us to the environmental constraint and limit to the economic growth. The empirical investigation of the PHH in the context of the ASEAN trade with advanced nations therefore, provide us with a fresh look at the environmental issues in the region and of the world as well. The current study may be a valuable addition to the existing literature on environmental economics. The results of the study provide us with useful guideline to formulate the policies for the protection of the environment and to design sustainable trade policies in the region. The results of this study are helpful for policymakers on the level of trade liberalization to their respective countries. It also provides information on the extent of regulations required to prevent the operation of the PHH. The results can also be used in the formulation of trade regulations and trade policy.

1.16 Conclusion of the Chapter

This chapter describes the background of the PHH and its theoretical connection with the EKC. This chapter also discusses some examples of the PHH. Moreover, the argument against the theoretical basis of the PHH also have been discussed. The problem statement, general and specific research questions also have been detailed. Finally, chapter highlights the importance and significance of a fresh research study on the PHH in the context of the ASEAN countries.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter provides critical literature review of the prior studies pertinent to the Pollution Heaven Hypothesis (PHH). Critical literature review highlights the gaps in the previous literature and provides the rationale to undertake the current study. The PHH has been studied theoretically and empirically using different specification, functional forms, estimation methods and datasets. Nevertheless, the results are mixed as no conclusive conjecture on the existence of the PHH can be established. The empirical literature about the PHH can be divided into four categories. This chapter reviews these categories in four different sections. Section 2.2 reviews the studies about the role of environment regulations for the PHH effect. While, Section 2.3 displays the empirical review of the studies about the link between trade and the PHH effect. Section 2.4 concludes the studies about FDI and the PHH effect. The main objective of the study is to investigate the PHH in the EKC framework therefore, Section 2.5 appraise the literature about the existence of the EKC. Finally, Section 2.6 synthesizes the whole literature. Lastly, Section 2.7 concludes the current chapter.

2.2 The PHH and Environment Regulation

The PHH holds the view that stringent environmental regulations in developed countries lead pollution-intensive industries to relocate from developed to developing countries and cause pollution to rise in developing countries. While, the Porter Hypothesis highlights that stringent environment regulations lead firms to implant the updated technologies rather than to relocate. Technolgy upgradation improves the competitiveness of industries and eventually improves the environment. The empirical studies reveal that environmental regulations play a different role in different perspectives. As in one of the early studies on trade in polluting industries, Low and Yeats (1992) found that stringency of environmental regulation had increased the net imports of 11 toxins in developed countries. This finding has supported the PHH stance. They further observed that developing countries had become competitive in the production of pollution-intensive goods.

Similarly, the critics of the EKC hypothesis like Selden and Song (1994) also pointed out that the presence of the EKC in advanced countries was the result of the relocation of dirty manufacturing industries from rich countries that had strict environmental regulations to those developing countries that had cheaper production costs and lax environmental regulations. They further stated that in some way, these lax environmental standards acted as a form of comparative advantage for developing countries.

Mani and Wheeler (1998) also observed that some countries tend to lag in pollution control efforts, thereby perpetuating environmental degradation. They therefore, concluded that pollution haven effects are expected to be transient, as pollution intensity has an elastic response to income growth in rich countries. Similarly, Kolstad and Xing (1998) also observed an effective role of environmental regulation in mobilizing the capital in pollution-intensive industries. In addition,List (2000) concluded that heterogeneous environment policies across the nations were the major determinant of the pollution in developing countries. They estimated the impact of environmental regulations on the decision of the Multinationals Corporations (MNCs) to relocate the plant.

List and Co (2000) and Cole and Elliott (2005) also found a significant role of environmental regulations to determine the US outbound FDI to Mexico and Brazil. On the same footing, Levinson and Taylor (2002) observed the increase of the imports of those industries of the USA whose abatement cost had increased following the environmental regulations. This increased import was from Latin America, Mexico and from other developing countries of the world.

Moreover, Levinson and Taylor (2008) observed the largest increase in the import of those goods and services of the USA whose abatement cost has increased. These goods are produced outside the country. In addition, R. A. Becker and Tang (2009) found a major shift in import toward poor countries due to change in environmental regulations. They investigated the impact of environmental regulation on the reduction of the production of pollution-intensive goods.

On the contrary, Levinson (1996) did not find the effect of environmental regulations on plant location decisions of the firms across the states in the USA. Moreover, he also concluded that "more than twenty years of empirical research has been unable to show convincingly that stringent environmental standards deter investment or that weak regulation attract investment". Similarly, Van Beers and Van Den Bergh (1997) did not find any significant impact of environment stringency on the trade of dirty goods in 21 OECD countries.

Xu (2000) examined the effect of environment stringency on the competitiveness of environmentally sensitive goods of 25 OECD countries excluding Turkey, Iceland, Hungry and East Asian countries. Their results also revealed no systematic change in trade patterns of these countries despite the implementation of more stringent environmental policies. They, therefore, rejected the PHH stance and suggested an insignificant role of environmental regulations in determining the trade flows.

Lofdahl (2002) argued that cost of production is the most important determinant of the MNCs decision to expand operation to other countries in search of the resources rather than environment regulations. Similarly, Kunce et al. (2002) also rejected the PHH stance about the MNCs plant location decisions. He examined the extent to which firms from oil and gas industries change timing and location of the production process in response to change in environmental regulations.

Cole and Elliott (2003) did not find either of the environment measure effective to influence the trade of dirty goods. They rather found that export of steel and iron industries that are considered most polluted industries was highest in capital-intensive countries. Similarly, they also found the export of paper and pulp industries and of non-ferrous metals were highest in mineral and forest abundant countries. They, therefore, concluded that it was the factor endowment rather than environmental regulations that determine the specialization patterns of a country.

Millimet and List (2004) also highlighted that relocation decision of a firm not only depend on the degree of environmental regulation but also on a host of other factors, such as labour costs and proximity to the markets and so on. They therefore, concluded that environmental regulations should be isolated from the variety of other determining factors to determine the existence of the PHH. Similarly,. Javorcik and Wei (2004) pointed out that despite the plausibility of the PHH, the empirical support had been limited in its favour. They examined the existence of the PHH in 25 transition economies of Eastern Europe and of former Soviet

Union as these states offer heterogeneous environmental standards. They also did not find any systematic evidence in support of the PHH. Moreover, Javorcik and Wei (2004) observed an opposite phenomenon than the predictions of the PHH. They found that the firms were migrating to those regions that had stricter environmental regulations.

Elliott and Shimamoto (2008) examined the impact of environmental regulations on Japanese outward investment to Malaysia, Indonesia, and Philippine and found that pollution haven is difficult to establish. They further studied that countries that do not have accumulated capital cannot attract dirty industries only with lax environmental regulations.

Similarly, Cole et al. (2010) also found limited support for the PHH from the disaggregated firm-level data of Japan. They found that the effects of environmental regulation on trade were dependent on the mobility of the industry. Lanoie et al. (2011) also found that strict regulations partially offset the production cost of the firms in OECD countries. In addition, Minghua and Yongzhong (2011) found a positive role of regulations to improve the competitiveness and environment-friendly products in three different regions of China. They negated the PHH and supported the Porter hypothesis which claims that by applying environmental regulations international competitiveness increased due to technological innovations.

On the same footing, from a large panel data set of exporting and importing nations, Costantini and Mazzanti (2012) found the evidence to support the Porter Hypothesis. They claimed that environmental regulations have increased the international competitiveness and technological innovations. They also claimed that environmental regulations were not always harmful to the production activities, especially environment taxes and energy regulations both increase the export competitiveness. The producers in competition would produce environmentally beneficial and quality goods.

O Rezza (2013) again found that Norwegian MNCs moved towards less stringent countries. They also found that MNCs that seek vertical efficiency, likely to stay in stringent environmental regulations and MNCs that seek horizontal efficiency tend to move to the countries that have less stringent environmental regulation. The vertical motives of the firm are in line with comparative advantage theory while horizontal motive is in line with the PHH. Lastly, From state-level data of the USA for the period 1977-1994 Millimet and Roy (2015) found that pollution-intensive industries like chemical, chemical products tend to move to states where environmental regulations were weak.

Hence, the empirical literature about the role of environment regulation to determine the location of the pollution-intensive industries have mixed outcomes. The studies such as Low and Yeats (1992), List and Co (2000), Cole and Elliott (2005), Levinson and Taylor (2008), R. A. Becker and Tang (2009), Rezza (2013) and Millimet and Roy (2015) hold the view that environmental regulations have significant role in relocating the pollution-intensive industries from developed to developing countries. While, the empirics like Levinson (1996), Beghin et al. (1997), Javorcik and Wei (2004) and Elliott and Shimamoto (2008) claimed that plant relocation decisions of industries not only depend on the differences in environmental regulations but also on host of the factors such as factor-endowment, labour cost, market penetration. Moreover, stringent environmental regulations also cause technologies to transfer to developing countries. The conclusive results therefore, cannot be drawn from the empirical literature.

2.3 The PHH and International Trade

The proponents of international trade hold that open trade brings new technologies, innovations, technical expertise and environmental improvement in developing countries. Nevertheless, the PHH portraits a different picture. According to the PHH, following the international trade, developing countries have become the pollution haven for advanced countries. The empirical literature has divided support to both stances.

For instance, Lopez (1997) found that trade liberalization has induced further loss of deforestation and biomass in Ghana. Takeda and Matsuura (2006) also concluded that export of pollution-intensive goods to advanced countries may have increased income and employment in East Asian countries. Nevertheless, it also has increased environmental degradation. Yang (2001) provided a strong support to the PHH by examining the environmental impact of WTO membership on the economy of the economy of Taiwan. He found that CO_2 emission in Taiwan has increased after the trade liberalization and production structure of the economy also have changed towards most polluting industries. Iwami (2001) also found that trade and industrialization in South East countries had aggravated the problem of environmental degradation.

Sánchez-Chóliz and Duarte (2004) analysed the impacts of international trade on sectoral level pollution in Spain. They evaluated the exports and imports in terms of direct pollution and indirect pollution (embodied CO_2 emission). According to their results, the sectors like mining, transport material, non-metallic industries, energy and chemicals are the export sectors that were most relevant to CO_2 emission. The construction, transport and food are the largest CO_2 importers. Similarly, Peters and Hertwich (2006) found that imports of Norway have 67%

embodied CO_2 emission and half of this pollution was originated from the developing countries. They investigated the environmental impact of trade embodied pollution in Norway.

Shui and Harriss (2006) examined the impact of trade between China and the USA on national and global CO_2 emission. They tried to answer the basic question of the PHH that how much pollution in China (developing economy) has increased to produce the export goods for the USA (an advanced economy). They also found that 7% to 14% of total CO_2 emission of China were the result of producing goods for the consumers of the USA. Moreover, the USA- China trade also has increased the world CO_2 emission. Moreover, Takeda and Matsuura (2006) found that environmental degradation has increased in East Asian countries owing to export of polluting industries to developed world. This export might have increased the employment, income nevertheless, it also has contributed to the environmental problem in these countries.

Azhar and Elliott (2007) investigated the existence of pollution haven hypothesis (PHH) and the capital-labour hypothesis (KLH) in the context of North-south trade. They found the evidence in favour of the PHH in case of the USA-Asia and the USA-Latin America trade. While in case of Japan-Asia and UK-Asia trade, they found KLH was more relevant. Chao and Eden (2007) examined the effects of trade liberalization on firm ownership and environment. They found that trade liberalization has shifted the ownership of firms from local to foreigners that resulted in more pollution in host countries. By examining the export patterns of developing countries between 1994 and 1997, Akbostanci et al. (2007) also found similar results. They observed that export of polluting industries of the developing countries had increased after the trade liberalization.

Elliott and Shimamoto (2008) probed the connection between Japanese out band (FDI) and stringent environmental policies in Japan and neighbour countries. They found that Japan has been trading its machinery to its neighbouring developing countries that have significant impact on pollution level in these countries. Levinson and Taylor (2008) measured the impact of pollution abatement cost on US net imports of manufacturing sectors from Mexico and Canada over the period from 1977 to 1989. As Mexico is a developing country, therefore, the analysis of US-Mexico trade provided a valid testing ground for the PHH. They also found that the pollution abatement cost in the USA was a significant determining factor of US trade with Mexico and Canada. By using six environment indices for the period 1882 to 2006. (Xiaoling, 2008) also concluded that international trade has aggravated the environmental pollution in China. Similarly, using panel data of the developing countries De-yong (2008) also found that international trade has worsened the environment of developing countries.

Guo et al. (2010) provided another support to the PHH. They examined the impact of inter-sectoral trade of 47 Chinese sectors and 67 sectors of the USA on national and global CO_2 emissions. They found that the USA imports had decreased the emission of polluted gases in the USA nevertheless, global emission in same period remained increasing. It indicates that the USA has shifted its pollution-intensive production process to other parts of the world and has been importing these products from developing countries. The same scenario they observed in the case of the USA trade with China.

Yunfeng and Laike (2010) highlighted that globalization of the international trade has generated several environmental problems. It has enabled the consumers of first world to shift the pollution associated with their consumption to developing countries. They applied input-output model to estimate the CO_2 emission generated by foreign trade for the period 1997-2007. They calculated that 10% to 27 % of total annual CO_2 emission was generated to produce the goods for foreign consumers. While, CO_2 emission embodied in the imports of China remained 4 % to 9% of the total annual CO_2 emission. They estimated that advanced countries had avoided a substantial amount of CO_2 emission because of the imports from the China rather than to manufacture those goods of same quality domestically. They further divided the trade embodied pollution into scale, composition and technique effect. They found that scale and composition effect increase the pollution embodied in trade while technique effect works to reduce pollution.

Atici (2012) found that export of dirty goods was the main determinant of CO_2 emission in the ASEAN. Moreover, he found that imports of Japan from the ASEAN do not cause pollution in the ASEAN countries while the imports of China stimulate the pollution per capita in these countries. Mizgajski (2013) analysed the CO_2 embodied in export and import of Poland with the rest of the world for the year 2004 based Global Trade Analysis Projects (GTAP) database. He employed input-output model that enable to assign responsibility of the pollution in the country to individual trade flows. It was found that export flows of the country contain significantly more embodied pollution than the import flows. Moreover, it was also found that exports to Germany that is an advanced country are more responsible of the pollution in the country.

From the analysis of bilateral trade between Spain and China, López et al. (2013) again confirmed a strong evidence for the support of the PHH. They found that China has become pollution haven for energy-intensive industries of Spain. Similarly, Gani (2013) also found that trade and industrial activities have a strong impact on pollution in Arab states. On the same footing, Chakraborty and Mukherjee (2013) supported the PHH from the analysis of trade and environment nexus in 114 countries for the period of 2000-2011. They used Environment Performance Index (EPI) as a measure of pollution. They also found that export of primary and manufactured goods of developing countries has caused environmental degradation in these countries.

From a panel dataset of 187 countries, Kanemoto et al. (2014) found that embodied CO_2 emissions had been on rise in developed and developing countries during the sample period of the study. They claimed that 72 percent of embodied flows of CO_2 were being generated from outside Kyoto Annex B[11] signatory that indicated the existence of the PHH type trade flows. They recommended that world pollution can be controlled only by reducing consumption of embodied emission. They further submitted that the major emitter of the GHH have applied aggressive environmental legislation, yet the net global air pollution was on the rise because these countries had been shifting the burden.

Similarly, Ren et al. (2014) also found that growing trade surplus was the main determinant of rising CO_2 emission in China. Moreover, FDI inflows also aggravated the environment situation. They used input analysis based on Generalized Method of Moment (GMM) to investigate the relationship among trade openness, export, import and CO_2 emission for the period 2000 to 2010. They recommended that China should transform FDI structure towards environment-friendly, improve energy efficiency and strive for low carbon economy.

From the US-India trade analysis between the period of 1991-2010 Sawhney and Rastogi (2015) concluded that decade of trade liberalization had made India a pollution haven for some polluting industries of the USA like chemical, steel, and iron. Furthermore, Ibrahim et al. (2015) also found that trade has environmentally degrading effects in South-East Asian

[11] "Annex B Countries/Parties are the signatory nations to the Kyoto Protocol that are subject to caps on their emissions of GHGs and committed to reduction targets–countries with developed economies. Annex B is an adjusted list of the countries identified under the more recent Kyoto Protocol. Annex B countries have their reduction targets formally stated". Source: United Nations Framework Convention on Climate Change

countries. Whilst, in another study on the trade, flows of 28 toxic chemicals from the US to the countries that have less stringent countries Tang (2015) also provided a strong support to the PHH. He found that the import of toxic chemicals of the USA has increased during the study period 1989-2006. The empirical work of Kiuila (2015) also indicated that trade had a negative effect on the environment of developing countries.

Ibrahim and Rizvi (2015) analysed the implications of international trade on the CO_2 emission in those countries of South East Asia that have highest trade to GDP ratios. This ratio indicates the level of trade openness of a country. They also found that trade had environmentally degrading effect in these countries. Moreover, Aller et al. (2015) concluded that as result of increasing trend in international trade there is a shifting of the industries from most developed countries to less developed countries. This global industrialization has certain implications for environmental quality of the developing countries. This trend has a negative as well as positive effect on the environment of less developed countries.

On the same footing, McCollough et al. (2016) also, proved the existence of the PHH. They found that pollution-intensive industries like the tyre industry of US has shifted production operations in India. This shifting has led to decrease emission in the USA while it has led to increase in emission in India. This study was a strong empirical support to the PHH stance that advanced countries are shifting the burden of the pollution to the developing world.

Enhancing the debate on trade and environment, Boamah et al. (2017) recommended that China should adhere to stringent environmental standards in international \trade. It should also endorse policies to promote energy efficiencies to mitigate the environmental effect of international trade. They contributed to literature by examining the impact of international trade on pollution in China for the period 1980 to 2014. Similarly, Libo and Chang (2017) found a significant impact of international trade on all pollution indicators in China. International trade seems to have increased the pollution in its all standards. They also recommended that industrial enterprises from China should strictly adhere to environmental standards and to clean development.

On the other hand, there is also empirical support against the PHH stance about trade and environment link. For instance, the empirical studies by (Jaffe et al., 1995; Jänicke & Weidner, 1997; Tobey, 1990) did not support the PHH claim that international trade would lead to displacement of pollution-intensive industries from more regulated developed countries to less regulated developing countries. Moreover, Beghin et al. (1997) found that trade liberalization did not lead to specialization in pollution-intensive agriculture sector. They analysed the impact of trade liberalization on economic growth and environment in Mexican agriculture sector.

Similarly, Mani and Wheeler (1998) also did not agree with the PHH stance. They used data for the period 1960-1995 and found that the PHH has not been relevant in developing countries. Economic growth had increased the technical expertise, cleaner investment and more stringent regulations in these countries. These changes resulted in countervailing effects against the PHH.

R. Becker and Henderson (2000) pointed out that most polluting sectors also had comparative advantages in other costs of production like labour productivity. Therefore, these advantages also affect the relocation decision of the firms. This stance was against the PHH that environmental concerns were sole factors behind the displacement of the dirty industries. Similarly,Smarzynska and Wei (2001) believed that past research had found weak evidence in the support of the PHH as previous studies had overlooked some important determinant of pollution. These studies therefore, did not correctly specify the models to investigate the existence of the PHH. The authors included some more variables in their model specifications like the level of corruption. They also did not find any robust support in favour of the PHH.

The critics of international trade also raised the spectre of race to the bottom". The advocate of this view hold that cost advantage of pollution haven effect would be neutralized owing to the competition. In this backdrop Wheeler (2001) examined race -to- bottom theory for the USA and three largest recipient of FDI: China, Mexico and Brazil. The results clearly rejected the prediction of the PHH. The air pollution of the cities of three FDI recipient countries have declined during the globalization regime.

Cole and Elliott (2003) also found a relatively small role of pollution haven effects as compared to other explanatory variables in explaining the pollution. They investigated the extent to which the PPH phenomena can influence the EKC of developing countries. They used a detailed data of North-South trade flows of pollution-intensive products and investigated the possible impact of these trade flows on water and air pollutants in South countries. Similarly, Frankel (2003) also rejected the fear that globalization of international trade necessarily hurts the environment in developing countries.

Raspiller and Riedinger (2004) also observed a paradoxical situation compared the PHH prediction. They found that pollution-intensive imports of France were from those countries that have stringent environmental controls. Similarly,Cole (2004) and He and Wang (2012) explained a different role of international trade than theorized by the PHH. According to them, trade liberalization usually leads to more economic growth and wealth accumulation. Then this accumulated wealth raises the awareness about the environmental standards. International trade also transfers modern and more advanced technologies from developed to developing countries. These modern technologies are more efficient and clean than traditional technologies of developing countries, therefore, in long run, international trade makes production processes clean and curtail pollution in developing countries.

Perkins (2005) argued against the PHH that internationally integrated market makes possible for the latecomer developing countries to get fast diffusion of the modern updated clean technologies. These modern technologies are less resource-intensive and less environmentally intensive. Frankel and Rose (2005b) also contributed to this debate. They investigated the impact of the globalization of the trade on the environment of a country at any given level of the GDP. They also found that trade has reduced three measures of pollution SO_2, NO_2 and particulate matters (PM_{10}).

Xiqin et al. (2006) analysed the effect of international trade on the environment in China. Although, they did not find any clear evidence of the PHH, yet they found that trade has certain consequences for the environment. On the same footing, Dietzenbacher and Mukhopadhyay (2007) also did not find any robust evidence in favour of the PHH. They examined the impact of import and export on various environmental indicators in India.

Kearsley and Riddel (2010) examined the EKC and the PHH from the bilateral trade between 100 developing and 27 OECD countries. They investigated the impact of bilateral trade and GDP per capita on seven local and global emissions like CO_2, Nitrous Oxide(NO_2), Sulphur Oxide (SOx), Volatile Organic Compound (VOCx), Carbon Mono Oxide (CO) and, Suspended Particle Matter (SPM). They also found a weak evidence for the role of the PHH in shaping the EKC, therefore, they rejected the PHH.

Honglei et al. (2011) examined the link between a set of the variables like FDI, economic growth, foreign trade and environmental pollution in 30 Chines regions. Their results revealed that free trade was not responsible for the pollution in China. Moreover, FDI was not found bad for local environment. By applying the simultaneous equation model, they confirmed that China had not become a pollution haven for the dirty industries of the world. Similarly, Beladi and Oladi (2011) also concluded opposite to the PHH. He claimed that global emissions can rather be decreased by the openness of international trade. They examined the impact of trade liberalization on CO_2 emission by using duopoly model of home and a foreign firm. Moreover, Honglei et al. (2011) also claimed that lax environmental regulations were not the cause of FDI inflows in China rather, huge economy and cheap labour have been the focus of the FDI inflows. The environmental regulations were not the cause of the pollution rather were the result of industrial structures of the China economy. They used two stages least squares model to estimate the impact of trade openness, FDI and environmental regulation for the period of 1993-2007 in 30 regions of China. Their results rejected the presence of the PHH in China. According to them, export-oriented economy is in the favour of local environment.

Similarly,H. Tan et al. (2013) found a very robust support against the PHH. They examined the effect of bilateral trade on CO_2 emission between China and Australia for a period 2002-2010. As per their results, embodied CO_2 emission in trade scenario was lower than the non-trade scenario and trade between Australia and China contributed to the reduction of global CO_2 emission. Thus, these results were quite opposite to the PHH trade patterns. Moreover, Poelhekke and Ploeg (2015) did not find support for the PHH at the sector level data. They analysed the PHH from the data set of 188 countries for the period 1996-2003.

Jebli et al. (2016) investigated the causal relationship between per capita CO_2 emissions, gross domestic products (GDP), renewable energy and non-renewable energy consumption and international trade for OECD countries their results show that increasing non-renewable energy and trade reduces CO_2 emissions. Therefore, according to these results, more trade and more use of renewable energy are effective strategies to combat global warming in these countries. Moreover, Jebli et al. (2016) also found that more international trade reduces global CO_2 emission. They investigated the causal relationships between per capita CO_2 emissions, gross domestic product (GDP), and international trade for 25 OECD countries.

Accordingly, Jebli et al. (2016) examined the long run relationship among economic growth, renewable energy, exports, imports and CO_2emission in 25 OECD countries for the period 1980 to 2010 using Fully Modified OLS (FMOLS) and Dynamic OLS (DOLS)panel cointegration techniques. They employed Granger causality test to examine short run and long-run causal relationship among the variables. The panel estimation confirmed the long-run equilibrium relationship among the variables. The FMOLS results indicated that increase in trade and renewable energy usage led to decline in CO_2 emission. Similarly, Keho (2016) also found that international trade has increased the energy efficiency in six Sub-Sharan African countries. They examined the impact of FDI and international trade on energy intensity in Six African countries using the period 1970 to 2011.

It is also argued that advanced countries strictly follow environment-related trade regulation set by international trade regulated bodies while trading with developing countries. The European Union has been an important trade partner of the developing countries and considered responsible for importing pollution-intensive goods from developing countries. In this backdrop Prakash and Potoski (2017) investigated the impact of commitment of EU countries with Kyoto Protocol while trading with 136 developing countries for the period 1981 to 2007. According to their analysis, the post -Kyoto export of developing countries to EU countries is associated with the decrease in CO_2 emission as compared to pre-Kyoto time period. Similarly, Mahmood and Alkhateeb (2017) found international trade helpful in reducing pollution in Kingdom of Saudi Arabia (KSA). They examined the impact of FDI and international trade on CO_2 emission in KSA for the period 1970 to 2016. They recommended that KSA should liberalize its international trade to tackle the environmental problems.

Hence, the empirical literature about the association between trade and environment also has diverse outcomes. The research studies, Zou and Wei(2010), Atici (2012), Gani (2013), Ren Yuan, Ma, Chen (2014), Kiuila (2015), He, and Baayramoglu (2016), and Prakash and Potoski (2017) concluded a positive impact of globalization of international trade on the environment of developing countries. They claimed that international trade has brought employment, income and updated technologies to developing countries. Whereas, Frankle (2003) Perkins (2005), Honglei,Xiaorog and Qiufeng (2011), Suns and Lau (2013), Keho (2016) and Mahmood and Alkhateeb (2017) supported the PHH implications about trade and environment relationship. They claimed that the PHH is evident in the case of international trade between developed and developing countries. The increased international trade in recent decades has made developing countries a pollution heaven for advanced countries.

2.4 The PHH and FDI

The prior literature reveals contrasting empirical findings about the effect of FDI on the environment of a country. The PHH claims that pollution-intensive industries of advanced countries have been shifting towards developing countries in the form of FDI and making the environment worse. While the critics of the PHH hold that FDI provides developing countries with new technologies, management skills and financial resources that eventually lead to the improvement of the environment. In literature, there is diverse empirical output about the link between FDI and environment.

For instance, Mabey and McNally (1998) noted that since from 1990s, developing and emerging economies have witnessed fivefold FDI inflows as a result of liberalization and globalisation. These investments have been mainly concentrated in the exploitation of natural resources and have significantly contributed to the increase in GHG. They therefore, suggested that FDI inflows should be invited with proper planning to avoid any harm to natural environment.

Winslow (2005) concluded that trade and foreign direct investment (FDI) had aggravated the environmental conditions in China. Cole and Elliott (2005) also found the evidence in favour of the PHH stance about the role of the FDI for the environment in developing countries. They examined the relationship between outward FDI from the USA to developing countries and the environment in developing countries. Similarly, Hoffmann et al. (2005) also found that FDI was the major cause of the pollution however, this impact was largely dependent upon the level of economic development of a country. They investigated the role of the FDI for environment in 112 countries of the world for 15-28 years.

Considering the complex nature of relation between FDI and pollution, He (2006b) used the simultaneous equation model to examine the effect of FDI on SO_2 emission in 29 Chinese provinces for the period 1999-2001. He also found a negative impact of FDI on SO_2 emission in Chines states and therefore, supported the PHH. Similarly, MacDermott (2008) found that FDI was flowing from 26 OECD countries to those developing countries that were with the higher level of pollution. Moreover, WEN and LIU (2008) concluded that trade and FDI has been the main factors behind the fast-economic growth of China however, Trade and FDI also contributed significantly to the environmental degradation and generated worse environmental problems in China.

Acharyya (2009) examined the effects of FDI on GDP and CO_2 emission in India for the period 1980-2003. He found significant impact of long-run inflows of FDI on CO_2 emission. The author further highlighted that the impact of FDI on local environment in India might be larger than the mere impact on CO_2 emission. Similarly, Baek and Koo (2009) found that FDI flows deteriorated the environment in India and China in short-run as well as in long run and supported the PHH. They applied cointegration and vector error-correction models to investigate the short-run and long-run relationship among the FDI, economic growth and environment in India and China. The results revealed a pivotal role of FDI in these two countries to determine the economic growth in short-run as well as in long-run through technological spill over and capital accumulation.

On the same footing, Pao and Tsai (2011) recommended that developing countries should protect environment first while attracting the FDI inflows. They examined the impact of FDI and economic growth on CO_2 emission in Brazil, Russia, India, China and South Africa (BRICS) countries for the period 1980- 2007. The results supported the existence of the PHH in these countries. Ben-Arye et al. (2012) also supported the PPH and rejected the FDI led growth. They investigated the long run relationship in Turkey among FDI, CO_2 emission and GDP for the period 1987-2009. They found a long run co-integration among the variables and causal relationship running from FDI to CO_2 emission.

To examine the impact of sector-specific FDI and CO_2emission in 18 Latin American countries Blanco et al. (2013) used Granger causality test for the period 1980-2007. They found robust support to the stance that FDI was the main factor behind the CO_2 emission emitted from pollution-intensive sectors. By examining the presence of pollution haven hypothesis in Gulf Cooperation Council (GCC) countries, Al-mulali and Tang (2013) applied panel cointegration estimation technique for the period 1980 to 2009. They found that there was long- run equilibrium relationship among the CO_2 emission, GDP per capita, FDI per capita, energy consumption. The FDI was found to have negative impact on environment, therefore, they supported the PHH. They recommended that GCC should be focused on the FDI that would bring new technologies and energy efficiencies.

There are also studies that have used composite indexes of environment rather than taking merely CO_2 emission or other gases as measure of environmental degradation to examine the PHH in developing countries. Chakraborty and Mukherjee (2013) is one of those studies. They employed the environment performance index (EPI) as measure of environment that includes the weighted average of all environment-related social and economic indicators They examined the international trade, FDI and environment link in developing countries using cross-section data. Their results also support the PHH stance that FDI has deteriorated the environment in developing countries. They also found that export, outward FDI and political and economic factors like politically efficient governance and civil liberties can reduce the environmental degradation in developing countries.

Ren et al. (2014) conducted a study to investigate the presence of the PHH in 18 industries of China for the period 2000-2011. They applied two-step GMM model to check the impact of FDI, international trade, export and import on embodied CO_2 emission. As per their results, trade surplus and inward FDI were the main determinants of environmental degradation in China. They further submitted that China had become pollution haven because of its foreign consumers. They recommended that China should promote clean FDI and should focus on energy efficient services to be a low carbon economy.

Wang and Chen (2014) also found a negative relationship between FDI and environmental degradation. They studied the relationship between FDI and environment in 287 Chinese cities for the period 2002-2009. They concluded that negative externalities of FDI specifically industrial SO_2 emissions can be curtailed in China by institutional development.

Aller et al. (2015) investigated the presence of the PHH for the period 1996-2010 in 177 countries of the world. They also found a support for the PHH. Similarly, Tai et al. (2015) also had the same conclusion. They found that FDI and pollution are positively related and FDI was found to lead the host country to the PHH effect however, this effect can be reduced by increasing the e share of aid in pollution abatement. From a similar type of the study from 27 selected developing countries for the time period of 2002 to 2008, Neequaye and Oladi (2015) also found that FDI flows deteriorated environment while environmental aid decreased the emission in these countries. They recommended that developing countries should choose clean FDI and should focus on stringent environmental regulations.

Similarly, Seker et al. (2015) found a long run negative effect of FDI on CO_2 emission in Turkey and supported the PHH. They examined the impact of FDI on CO_2 emission for the period of 1974-2010. They used autoregressive distributed lag (ARDL) to test the long run relation between the variables. They recommended that Turkey should allow only those FDI flows that bring clean technologies. Moreover, Neequaye and Oladi (2015) also recommended that developing countries should allow only FDI that brings clean technology. They should also focus on stringent environmental regulations. They employed fixed-effect model to examine the impact of FDI inflows on environmental degradation in 21 selected developing countries using the time of 2002-2008 and found that FDI has deteriorated the environment in these countries. In addition, Shahbaz et al. (2015) also found that FDI has enhanced the environmental degradation in low, middle and even in high-income countries.

Riti et al. (2016) conducted an empirical investigation in Nigeria for the period 1980-2013 to examine the link between of manufacturing export, FDI and pollution. From Ganger causality test and bound cointegration test, they found deteriorating impact of manufacturing export and FDI on CO_2 emissions.

Sun et al. (2017) tried to resolve the debate whether the large inflow of the FDI can be considered responsible of the mounting CO_2 emission in China. They used Autoregressive Distributed Lag Cointegration (ARDL) model to estimate the relation among CO_2 emission, FDI, GDP, energy use, economic freedom, trade openness and financial development for the period 1980-2012. The bound test confirmed the long run equilibrium relationship among the variables. CO_2 emission was found to increase by 0.58% following the 1% increase in the inward FDI. It was a robust evidence in the support of the PHH.

Similarly, Shao and Shao (2017) found a significant negative impact of FDI on carbon intensity in low income, middle income and high-income countries, They carried out this study in 188 countries for the period 1990-2003 to clarify the relationship between FDI and carbon intensity. Considering the issue of endogeneity, they employed dynamic panel model to investigate the issue with fresh data. According to their results, FDI has significantly deteriorated the carbon intensity in host countries.. Moreover, Bokpin (2017) also found a significant increase in pollution in 2010s as compared to 90s in African countries. He attributed this increase in pollution to increase in FDI in African countries. Furthermore, Sapkota and Bastola (2017) confirmed the validity of the PHH for Latin American countries. They examined the impact of FDI on income and environment in 14 Latin American countries. They used traditional panel estimation method Fixed Effect Model (FEM) and Randon Effect Model (REM) while controlling the impact of human capital, energy use, population density and unemployment rate.

On contrary, Beghin et al. (1997) did not substantiate the PHH stance. They concluded that trade and investment liberalization police have not led the Mexican economy to specialize in pollution-intensive industries. They analysed the relationship between trade, growth and environment for Mexican agriculture sector. They found that liberalized trade and investment policies can mitigate the environmental degradation in developing countries these policies are accompanied by targeted effluent taxes. G. Eskeland and Harrison (1997) also rejected the PHH stance about the role of FDI and free trade for environmental degradation in Latin American countries. They argued that foreign companies are more energy efficient and use less energy than their local counterpart companies. They highlighted the fact that FDI in Latin American countries was not linked to the development of any pollution-intensive industry rather FDI has caused to improve the environment owing to better environmental standards.

It is also argued that Multinational Corporations (MNCs) do not tend to invest in pollution-intensive industries of the developing countries because environmental cost is not a significant determinant of plant location. Clapp (1998) challenged this assertion that majority FDI in poor nations operate in most hazardous industries. He rather asserted that FDI in developing countries mostly operated in services and upgraded industrial sectors.

Smarzynska and Wei (2001) pointed out little empirical support for the PHH despite its popularity and plausibility. They identified that FDI might be positively correlated with the environmental pollution in developing countries owing to bureaucratic controls, corruption and lax environmental regulations. They incorporated corruption level and environmental standards of host countries in the PHH model and investigated the impact of FDI on pollution in 24 transition economies using firm-level data. Despite these improvement in model specifications, they did not find any robust support in favour of the PHH. Similarly, although G. S. Eskeland and Harrison (2003) claimed that outward US FDI is energy efficient and used cleaner energies. Though, they found some evidence that foreign investors locate in those sectors that have high level of air pollution, yet the evidence is not robust.

Haisheng et al. (2005) stated that there was no certain impact of trade and FDI on the environment. They found that FDI had a positive impact on economic growth and help to invent new technologies to reduce pollution. This study was a support to the stance of Porter hypothesis. Similarly, Aliyu (2005) found that FDI was not a significant factor to explain the level of environmental damages and energy usage in 14 non-OECD countries. He examined the effect of inward FDI inflows on CO_2 emission, SPM, temperature and energy usage.

Considering the complex relation between FDI and environmental pollution, He (2006a) developed the simultaneous equation model to investigate the FDI and industrial SO_2 pollution nexus in 29 states of the China. The result indicate a small impact of FDI on SO_2 emission as 1% increase in FDI lead mere 0.098% increase in SO_2 emission. Merican (2007) also found different role of the FDI in different countries of the ASEAN. They examined FDI and pollution nexus in the ASEAN counties for the period 1970-2009 using the ARDL approach. The results showed a negative impact of FDI on pollution in Thailand, Philippine and Malaysia. However, FDI did not seem to worsen the environment of Indonesia and Singapore. In Singapore this result may be owing to dominance of tertiary sector.

Liang (2008) argued that FDI and trade had beneficial impact on the environment in developing countries. The MNCs bring updated and efficient technology, change the industrial output and crowd out inefficient local firms. He examined the impact of FDI on local air pollutants in China taking industrial composition and other social and economic factors as controlled variables. The results showed an overall beneficial impact of FDI on local pollution. Similarly, De-yong (2008) also found that FDI has improved the environment in developing countries. However, their results confirmed the environmentally worsening effect of the international trade. Moreover, they also confirmed the presence of the PHH for developing countries. Moreover, Li-yan (2008) also has similar findings. They examined the impact of FDI on environment for the period 1992 to 2006 in China by applying a simultaneous equation model. The result showed that FDI has reduced the pollution in China through optimizing the industrial structure and upgrading the technology.

Lee (2009) implied bounds cointegration test and Granger causality approach to examine the relationship between FDI, GDP and pollution in Malaysia. Their results revealed only long-run causality running from GDP to FDI. Similarly, Dinçer and Rosen (2010) pointed out that FDI that is accompanied by green technologies can bring improvement in environment at very fast rate. Honglei et al. (2011) also, generated arguments against the PHH. They examined the effect of a set of variables like FDI economic growth, foreign trade on environmental pollution in 30 regions of China. They found that FDI was not destructive for the local environment. From the simultaneous equation model, they concluded that China was not a pollution haven of the advanced countries. They further submitted that China's huge economy and cheap labour are the main determinants of FDI inflows rather than lax environmental regulation.

Lan et al. (2012) found a positive link between polluting emissions and increased FDI in those provinces of China that have low level of human capital. However, this link was found negative in the provinces that have high level of human capital in addition, Al-mulali and Tang (2013) found that FDI has a negative effect on the CO_2 emission in those countries that have the well-developed infrastructure. They found that FDI had brought energy-efficient technologies to the host countries. In their studies of the PHH in Gulf Cooperation Council (GCC) countries used a multivariate framework for the period 1980-2009. The results of Pedroni cointegration test indicate a long-run equilibrium relationship among GDP growth, FDI and CO_2 emission. Moreover, Fully Modified OLS (FMOLS) revealed that GDP growth and energy consumption lead to increase in CO_2emission while FDI cause to decrease the CO_2 emission. In addition, Granger causality showed a short run causal relation running from GDP growth and energy consumption to CO_2 emission and no causal relation running from FDI to CO_2 emission. They therefore, rejected the PHH and recommended the GCC countries to frame policies to attract more FDI as it was important determinant of GDP growth.

The high economic growth in emerging economies is also attributed to FDI inflows. They also have witnessed fast increase in CO_2 emission in same period. In this backdrop,Gholipour Fereidouni (2013) carried out an investigation to examine the possible impact of FDI on CO_2 emission in 32 emerging economies. They applied fixed effect model (FEM) and generalized method of moments (GMM) estimation technique for the period 2000 to 2008. Their results also did not find any significant contribution of the FDI in CO_2 emission. They found economic growth, urbanization and energy consumption were important determinant of the CO_2 emission.

In Sub Saharan African countries Kivyiro and Arminen (2014) also find different contribution of the FDI for environment in different countries. They investigated the causal link among FDI, CO_2 emission, energy consumption and economic growth in six countries namely Kenya, South Africa, Zambia, Zimbabwe and the Republican of Kango. The ARDL results supported the EKC hypothesis for Kango, Zimbabwe and in Kenya. In addition, FDI was found to increase the pollution in some countries while opposite effect of FDI could be observed in some other countries. These results made it impossible to draw universal conclusion about the contribution of the FDI for environmental degradation.

Using two-equation model Hao and Liu (2015) investigated the direct and indirect impact of FDI and trade on CO_2 emission in 29 Chinees states for the period 1995 to 2011. The results revealed a negative direct effect and positive indirect effect of the FDI on CO_2 emission while direct effect was found to dominate the indirect effect. FENG and LUO (2016) also concluded that FDI was mainly attracted by infrastructure and technology rather than lax environmental conditions. They examined the impact of environmental stringency on FDI in 30 regional states of China. They found that the PHH held to some extent in the western region of China. They also found that the coastal region with stringent regulations also attracted clean FDI. They also did not find any robust support for the PHH.

Kostakis et al. (2017) claimed that FDI has increased CO_2 emission in Brazil and has decreased in Singapore. They assessed the impact of FDI on CO_2 emission in Brazil and Singapore for the period 1970 -2010. Moreover, they highlighted that sectorial composition of the FDI was more significant determinant of the environmental degradation. Using time series data for the period 1980-2010.

Thus, prior literature unfolds contrasting empirical findings about the impact of FDI on environment in host countries. For instance, the empirical studies such as De-Yong (2008), Honglei et all (2011), Almulalaai and Tang (2013) and Hoa and Liu (2015) claim that FDI has brought technologies, innovations, financial growth and administrative skills to host countries that eventually leads to environmental improvement. On the contrary, Mobey and McNallay 1(998), Winslow (2005), HE (2006), Wen and Liu (2008), Acharyya (2009), Pao and Tsai (2011), Chakraborty and Mukherjee (2013), Tai,Chao and Hu (2015), and Shao and Shao (2017) supported the PHH stance about the role of FDI for environment in host countries. They argued that FDI is mostly concentrated in those sectors where environmental resources are under-priced. Consequently, FDI deteriorate the environmental quality in developing countries. The review has successfully brought together to controversies surrounding the PHH and trade debate. The debate is inconclusive and further studies in different parts of the world is required to test further the PHH especially in the Asian and the ASEAN region.

2.5 Empirical Review of the EKC

There are numerous studies that empirically examined the EKC with different data set and with different time periods in all almost all parts of the world and have diverse outcome. For instance, De Bruyn (1997) found empirical support to the EKC hypothesis in Organization Economic Cooperation and Development (OECD) and socialist countries. He employed a division index methodology to investigate the relation between SO_2 and income growth and found income as an important determinant of SO_2 emission. He also claimed that high incomes countries have more determined environment policies as compared to poor countries hence, provided a support to the EKC. Cole (1999) stated that that theoretical debate in the 1960s, 1970s and 1980s did not simplify the effect of economic growth on environmental conditions of a country. The opinion remained divided between those who were in favour of continued economic growth and believed in the capabilities of new technologies and resource substitution to beat the limits on economic growth put by environment and those who believed that economic growth could not be carried out unbridled. He also revealed that empirical tests in the 1990s did not conclude any unique association between income growth and pollution. Some local pollutants like SO_2 and PM_{10}[12] were found to decrease in developed countries may be because of economic growth nevertheless, worldwide these pollutants had an increasing trend. This fact raised the possibility that economic growth was simply causing a shifting of the pollution from the developed countries to the developing countries. Hettige et al. (2000) also, found a partial support for the EKC hypothesis. They investigated the connection between industrial pollution and income growth and found only manufacturing share in total GDP was following the EKC growth trajectory. Stern and Common (2001) also submitted the same that there were different income-pollution paths rather than a uniform EKC relation between income and pollution. They further inferred that decline in pollution in advanced countries was a time-related rather income related phenomena.

On the other hand, Taskin and Zaim (2000) revealed an N-shape[13] relationship between environmental efficiency and income by using nonparametric production frontier techniques

[12] These particles are less than 10 microns in diameter - about 1/7th the thickness of the a human hair - and are known as PM_{10}. This includes fine particulate matter known as $PM_{2.5}$. PM_{10} is a major component of air pollution that threatens both our health and our environment .

[13] N shaped relation implies that pollution first increases then decreases with the increase in come then again start to increase at higher income level may be due to mass consumption of the society at higher income level.

for the 1975-1990 time period in 52 countries. The turning points for the N-shape curve were found at $5000 and $12000 per capita respectively. Similarly, Martínez-Zarzoso and Bengochea-Morancho (2004) also found a N-shaped EKC in a panel of 22 OECD countries.

Lomborg (2001) strongly favoured the EKC notion in his book "Skeptical Environmentalist". He argued that developing countries would overcome environment problems followed by economic growth. He predicted that developing countries of the day would also experience a decline in pollution as currently advanced countries have experienced. Bartoszczuk et al. (2002) also supported the existence of the EKC for developed countries nevertheless, they also claimed different turning points of the EKC for different countries. They used an agent-based regression model and found that simulation technique was best especially when mathematical function between pollution and income is very difficult to attain.

According to Dasgupta et al. (2002), the EKC will spread to a horizontal line following the globalization "race to the bottom"[14]. While the optimistic critique suggested that EKC would drop and shifts to left as economic growth would generate fewer pollution in the middle phases of industrialization "the scenario of Revised EKC"[15]. However, both schools of thought have not been supported by ample empirical research yet.

Similarly, Khanna and Plassmann (2004) pointed out that income elasticity of the pollution is not same for all types of pollutants rather it is dependent on the ability of a country to spatially detach the consumption and production process, given the preferences of consumer and the technology status of that country. They also found the elasticity changing at lower income from

[14] A state of competition where companies, states or nations attempt to undercut the competition's prices by sacrificing standards, safety, regulations, wages and so on. A race to the bottom can also occur between nations and regions .

15 It is view point of optimistic critic of the EKC that this curve is dropping as pollution begins to fall at the early stages of economic growth.

positive to negative for those pollutants whom spatial separation was easy as compared to those pollutants whose spatial separation[16] was not easy. They further claimed that in the United States of America (USA) household were not at the income level where demand for environment quality had changed the income-environment relations for all sort of the pollution. Galeotti, Lanza, et al. (2006) also concluded the same that the EKC was not a stable between income and pollution rather this relation was very sensitive to the functional form of the model. Plassmann and Khanna (2006) used a standard static model of the EKC without assuming any specific functional form nevertheless, they found that appropriate preferences of economic agents lead to an EKC type transition.

Mazzanti et al. (2006) conducted a study for 109 countries over the period 1959-2001 by using a new estimation technique to deal the problem of heterogeneity. They also concluded that the EKC type transition was not exclusive and unique rather it was specific to the region, country and to the time of the study. Similarly, Galeotti, Manera, et al. (2006) pointed out that the EKC hypothesis was a fragile idea. They, therefore, recommended further meaningful analysis of the EKC hypothesis. Furthermore, Auci and Becchetti (2006) also found different turning points of the EKC. They used CO_2 emission from fossil fuel burning as a measure of pollution taken from World Development Indicator (WDI) dataset over the period 1960-2001 for 197 countries.

Johansson and Kriström (2007) revealed that it was the technology level and preference of a society that determine the shape of the EKC. They recommended that countries should not follow "grow now clean later" before analyzing the costs and benefits of doing so. Li et al.

[16] Distinction between the pollutant that contributes to local pollution and those pollutants which contribute to non-local, regional or global pollution.

(2007) carried out a meta-analysis of 58 studies about the EKC. According to their results, the characteristics of data, study methods, estimation techniques, and the type of the pollutant were the significant determinants of the non-existence or existence of the EKC.

While Liu (2008) recommended that developing countries should not wait for the turning point of the EKC. He pointed out that environmental degradation in developing countries might reach at an irreparable stage before the start of an automatic improvement in the environment. However, Van Lantz and Martinez-Espineira (2008) found the evidence in favour of the EKC hypothesis. They examined the EKC for bird population and GDP per capita for 37 Canadian states.

Mazzanti et al. (2008) studied the implication of the EKC for the different sectors of Italian economy for the period 1990-2001. They found that the pollutants like GHG produce inverted U-shaped EKC while pollutants like SO_2, NOX[17] and PM_{10} produced N-shaped EKC. The disaggregated sectoral analysis revealed the heterogeneous relation between pollution and income for different production branches like manufacturing, agriculture and services. The Service sector portrayed an inverted N-shaped EKC relation for most of the pollutants. While manufacturing industry tend to have a mixture of inverted U and N-shapes connection for different pollutants. They therefore, concluded that the EKC had different EKC trajectories within an economy. Managi and Jena (2008) used state-level industry data from India to investigate the relationship between environment productivity and pollutants like SO_2, NO, SPM for the period 1991-2003. They found that common environmental productivities have decreased over the time in India and scale effect of production dominated over the technique

[17] NOx is a generic term for the nitrogen oxides that are most relevant for air pollution, these gases contribute to the formation of smog and acid rain, as well as tropospheric ozone .

effect. Resultantly, the joint effect of economic growth on environment productivity was not positive. They, therefore, rejected the EKC transition for Indian states. Similarly, Akbostancı et al. (2009) also did not find any support for the EKC for the Turkish economy. They found the relationship between CO_2 and income was monotonically increasing for the period 1968-2003.

Caviglia-Harris et al. (2009) tested the legitimacy of the EKC with Ecological Footprint (EF)[18], a wide-ranging measure of pollution that measures environmental capital carrying capacity of a nation. They found a very partial empirical support for the EKC. They further discovered that world economies had to cut the energy consumption by fifty per cent for the emergence of a significant EKC relationship. Kumar and Khanna (2009) estimated Environment Efficiency (EE) and Environment Productivity (EP) and compared them over the period 1971 to 1992 in different countries. They found that the opportunity cost of the adaptation of environment-friendly production process in developed countries getting reduced after a critical level of income. However, in comparison, this cost has been on the rise in developing countries. It was a support to the EKC stance that developed countries are in better position to cope with the environmental issues.

While Mills and Waite (2009) used an index of biodiversity threat in 35 tropical countries to test the EKC. They, however, noted that only wealth was not a dependable meter of better conservation practice. Similarly, Carvalho and Almeida (2009) also concluded that only

[18] "The ecological footprint is a measure of human demand on the Earth's ecosystems. It is a standardized measure of demand for natural capital that may be contrasted with the planet's ecological capacity to regenerate. It represents the amount of biologically productive land and sea area necessary to supply the resources a human population consumes, and to assimilate associated waste. Using this assessment, it is possible to estimate how much of the Earth (or how many planet Earths) it would take to support humanity if everybody followed a given lifestyle. For 2007, humanity's total ecological footprint was estimated at 1.5 planet Earths; that is, humanity uses ecological services 1.5 times as quickly as Earth can renew them. Every year, this number is recalculated to incorporate the three-year lag due to the time it takes for the UN to collect and publish statistics and relevant research".

economic growth could not be the substitute of multi-dimensional environment policies to curtail the GHG in the world. They investigated the role of the Kyoto Protocol as a global policy to curtail CO_2 emissions in a sample of 167 countries for the period of 2000 to 2004. They employed Fixed Effect Model (FEM) considering the spatial dependence of emission data. Their results suggested the existence of an N-shaped global EKC and the latent significance of Kyoto Protocol[19].

Halkos and Tzeremes (2009) analyzed the relationship between environmental efficiency and national income by General Method of Movement (GMM) estimation technique in 17 OECD countries over the period 1980-2002. They also claimed that the only surge in economic activities did not lead to effective environmental protection, therefore, there was no guarantee for any EKC type relation between economic activities and environmental quality. Likewise, Galeotti et al. (2009) also criticized the EKC hypothesis owing to lack of sufficient statistical testing and questioned the stationary properties of the series that have been used to test the EKC. Aslanidis and Iranzo (2009) examined the EKC hypothesis between per capita income growth and CO_2 using the appropriate econometric technique for OECD countries for the period of 1971 to 1997. They also did not find any evidence of the EKC.

Contrarily, the findings of Jain and Chaudhuri (2009) from time series data of different countries provided a support to the EKC hypothesis. They found that developing countries like India and China were on the rising part of the inverted U- shaped EKC. While the countries like the United Kingdom (UK) and Germany were on the falling part of the EKC. The countries

[19] "The Kyoto Protocol is an international treaty, which extends the 1992 United Nations Framework Convention on Climate Change (UNFCCC) that commits State Parties to reduce greenhouse gases emissions, based on the premise that (a) global warming exists and (b) man-made CO_2 emissions have caused it".

like the USA and Canada were on the rising part of the N-shaped EKC. They also provided us with the degree of the efforts required for different economies to reduce the pollution. According to Kijima et al. (2010), a substantial amount of empirical studies on the EKC had been undertaken since from 19990s. The EKC had been accepted as an empirical regularity, though there was no concrete proof of the existence of the EKC. They revealed that studies about the EKC had estimation issues therefore, new developing economic should use new econometric models to examine the EKC transition. He and Richard (2010) also found very partial evidence for the existence of the EKC in the Canadian economy. They estimated the relationship between CO_2 and GDP per capita for 1948 - 2004 by using semi-parametric and flexible nonlinear parametric modelling methods. They found that oil shock of the 1970s had important implications for the less pollution-intensive manufacturing process in Canada.

Nevertheless, Xinlian et al. (2010) supported the EKC process for China. They categorised 30 China's districts into three clusters based on GDP per capita and the ratio of industrial production to GDP. They investigated the existence of the EKC in each cluster independently for the period from 1997 to 2007 and found a clear support for the EKC. Similarly, Jian and Shanshan (2010) also indicated that China was close to the turning point of the EKC. Moreover, Lipford and Yandle (2010) indicated that worldwide CO_2 would increase with the increase in the incomes of the developing countries. They analyzed emissions trends in G8 +5 countries and concluded that cost of reducing CO_2 would be comparatively high in developing countries as compared to developed countries. This high cost may be due to the specialization patron of the developing countries.

Contrarily, Naglis-Liepa (2011) claimed that there is nothing automatic to environment solution as suggested by the EKC. They examined the EKC in Latvia between economic growth and the GHG. They compared the changes in household energy consumption in response to economic growth. Similarly, Masih and De Mello (2011) did not support the EKC relation between CO_2 per capita and income per capita They examined the association between income and CO_2 emission per capita in Saudi Arabia over the period 1975-2003 by using a newly developed time series technique Long Run Structural Mode (LRSM). They, therefore, concluded that only surge in per capita income is not sufficient to curtail per capita CO_2 emission rather economic growth should be accompanied by an active industrial policy. They further recommended that tastes and preferences of the rich individuals also essentially to be environment-friendly.

However, Jaunky (2011) provided some empirical evidence in favour of the EKC for some countries. He provided a new framework to investigate the presence of the EKC notion by employing a panel vector error-correction mechanism (VECM). He used CO_2 emission and GDP of 36 developed countries over the period 1980–2005. He observed that one per cent increase in GDP produces 68 per cent increase in CO_2 emissions, in the short-run and 22 per cent in long run. The lower income elasticity in long-run does provide the evidence of an EKC and indicated that CO_2 emission is stabilizing over time in the rich countries.
According to Zilio (2012), the theoretical basis of the EKC hypothesis are not consistent to the economic, social and institutional framework of developing countries. It is mainly owing to the disparity in income distribution and the weakness of the environmental institutional framework in developing countries. They, therefore, concluded that the idea of waiting and growing to achieve improvements in environmental quality is not relevant for developing countries.

Most of the panel data studies that have used Fixed Effects Model (FEM), Random Effect Model (REM) and Variable Coefficient Model did provide the evidence for the EKC transition for CO_2 emission. Later, co-integration time series studies about individual countries and about panel dataset also provided some evidence for the existence of EKC for CO_2 emission. The empirical investigation of Esteve and Tamarit (2012) about the EKC was one of those studies. They modelled the long-run association between CO_2 per capita and GDP per capita in Spanish economy for 1857 to 2007 period and found the existence of an EKC. Similarly, Saboori et al. (2012b) also found EKC relation between CO_2 emissions and GDP in both in long run and in short for Malaysia over 1980 to 2009 time period by using Auto Regressive Distributed Lag (ARDL) method of estimation. Borhan et al. (2012), also supported the EKC hypothesis in case of CO_2 emission in eight Asian countries for the period 1965 to 2010 period by using two-stage least square (2SLS) method of estimation.

Zanin and Marra (2012), investigated the EKC for CO_2 emission using a flexible approach from additive mixed models for Australia, Austria, Canada, Denmark, Finland, France, Italy, Spain and Switzerland over the period 1960–2008. They found the relationship between pollution and income was inverted U-shaped for France and Switzerland, an inverted-L-shaped for Finland and Canada, M-shaped for Denmark, a weak N-shaped for Austria and a nonlinear increasing for Australia, Italy and Spain.

While Cox et al. (2012) did not find the evidence in support of the EKC from a detailed survey of household transport emissions from the USA. They found that richer families on average had more and newer vehicles. Nevertheless, they did not have less polluting vehicles as richer families did not select to bear the social cost of pollution by vehicle emissions. Therefore, the evidence did not support the EKC stance that at the higher income level household demand environment quality.

K.-M. Wang (2012) did not find support for the EKC hypothesis for CO_2 emission in 98 developed and developing countries for the period 1971 to 2007. They found that regime of low economic growth has a negative effect on oil-related CO_2 emissions and in the medium economic growth regime; economic growth has a positive effect on CO_2 emissions from oil consumption and in the regime of high-growth the effect of economic growth is insignificant. Puzon and Alonzo (2012) stated that latecomers developing countries would generate less pollution than that of the advanced countries at same per capita income level. The developing countries would learn from advanced countries and can use more effective pollution abatement technologies of advanced countries. They used contextual case of East Asian economies and concluded that latecomer countries in the process of industrialization could be benefited from being late.

From a meta-analysis of 69 EKC studies, Choumert et al. (2013) concluded that results of the EKC studies differ mainly due to different control variables, different geographical areas, different econometric strategy and due to different measures of the environment. Wang (2013) also endorsed that the results of the EKC studies were sensitive to its functional form. They found different EKC pattern for SO_2 emission and CO_2 emission in OECD countries.

While presenting a critical history of the EKC, Farhani et al. (2014) asserted that the results of EKC studies have a very fragile statistical foundation. They recommend that new, fresh, efficient and decomposed models can help to detect the true association between environment and economic development and might result in a new form of the EKC pattern. In another single country analysis of Ecuador for the period 1980-2025, Robalino-López et al. (2014) tried to grasp the conditions of a country that can lead the EKC transition even in the medium-term time period. Nevertheless, their results did not indicate the fulfilment of the EKC transition in the mid-term time. However, their estimated results did indicate that Ecuador was on the way to achieve environmental equilibrium in the future if income growth was accompanied by the development of productive structure and the use of renewable energy resources.

After highlighting the econometric issues in testing the EKC hypothesis with panel data, Chow and Li (2014) used a simple t-test to examine the relationship between CO_2 emission and per capita and the square of log GDP per capita in 132 countries over 1992 to 2004 time period. Their result confirmed that coefficient of the square of log GDP per capita was negative significant. Hence, it was a very strong support to the EKC hypothesis.

Jobert et al. (2014) revisited the EKC hypothesis using Empirical Iterative Bayes' estimator, that can arrest the heterogeneity among the cross-country data. They investigated the relationship between carbon dioxide CO_2, real GDP per capita and energy consumption per capita in 55 countries for 1970 to 2008. Their estimation provided country-specific and worldwide information about the environment- income relation. Their results rejected the EKC hypothesis for 47 out of 51 countries.

Ogundipe et al. (2014) did not validate the EKC hypothesis in low and middle-income countries of Africa. F. Tan et al. (2014) analyzed the data of CO_2 emission and GDP per capita for the 1975-2011 period with cointegration and causality technique in Singapore that is high-income country. Their results clearly indicated a positive relationship between these two variables, as 1 per cent increase in GDP led 1.2 per cent increase in CO_2 emissions. Therefore, they inferred that Singapore was on the left side of the EKC however, there was some indication that Singapore might experience a drop in CO_2 emissions soon in future. Yavuz (2014) also found the EKC relationship in long run between CO_2 emission and income. He examined the EKC hypothesis for Turkey by using CO_2 emission over the period 1960 to 2007.

Apergis and Ozturk (2015) examined the EKC relationship between CO_2 and income in 14 countries of the Asia for the period 1990 to 2014 using Generalized Method of Movements (GMM). They found a strong support for the presence of the EKC. However, Al-Mulali et al. (2015) did not support the exitance of the EKC in Vietnam. They examined EKC relation using the time 1981-2011 and employed Autoregressive Distributed Lag (ARDL) to estimate the relationship between income and pollution. Though, they did find a support to the PHH.

Jebli et al. (2016) investigated EKC relationship between GDP and CO_2 emission in 25 OECD countries using the time period 1980-2010. The Fully Modified Ordinary Least Squares (FMOLS) results verified the existence of the EKC relationship. Using the time series data about Brazil, China, India and Indonesia for the period 1970-2012 Alam et al. (2016) found that EKC was valid for Brazil, China and Indonesia. Nevertheless, this relation was not found valid for India.

Hence, the empirical literature about the EKC has divided outcome. The studies like Lomborg (2001), Van Lantz and Martinez-Espineira (2008), Jain and Chaudhuri (2009), Jaunky (2011), Borhan et al. (2012), Chow and Li (2014), Apergis and Ozturk (2015), and Jebli et al. (2016) empirically proved the legitimacy of the EKC. While researchers like Khanna and Plassmann (2004), Galeotti, Lanza, et al. (2006), Liu (2008), Lipford and Yandle (2010), Zilio (2012), Jobert et al. (2014), and Al-Mulali et al. (2015) did not found empirical support for the EKC. Moreover, they hold the view that developed countries are on falling part of the EKC as they have relocated pollution-intensive industries to developing countries. The studies are also numerous that have mixed outcome about the income environment relation like Cole (1999), Hettige et al. (2000), Dasgupta et al. (2002), Caviglia-Harris et al. (2009), Kijima et al. (2010),.He and Richard (2010), and Zanin and Marra (2012). Similarly, Taskin and Zaim (2000) and Carvalho and Almeida (2009) found N-shaped income environment relation.

2.6 Summary

Although, numerious studies have theoretical and empirically reviewed the PHH by using different specification and data yet conclusive results are pending. The PHH claims that the developing countries have become pollution heaven for developed countries due to trade and investment liberalization policies. The advanced countries are clean as pollution-intensive industries have migrated to the developing countries to take advantages of cheap environment resorces. Consequently, the developed countries tend to import pollution-intensive goods from the developing countries. The proponents of the PHH laso claim that the consumption of pollution goods in the developed countries have not come down yet. The world pollution can be curtailed only if developed countries are able to control the consumption of the pollution-intensive goods.

Contrastingly, the Porter Hypothesis reveals a different story. According to this hypothesis, trade and Investment have beneficial impact on environment in the developing countries. They reap the advantage of specialization and large-scale production. Trade and investment liberalization policies also bring updated and energy efficient technologies to the developing countries. The long run impact of these policies therefore, is beneficial for wealth generation, sustainable development and environment.

The empirical literature reveals inconclusive results about the two above-mentioned hypotheses. The critics of the PHH argue that most of the analysis about the PHH is based on neo-classical trade theory of comparative advantage. The neo-classical trade theory ignores the dynamic factors like technology and market access that are the most important determinants of the location of any industry. Furthermore, it is also argued that pollution-intensive sectors are capital intensive while advanced countries are also capital abundant countries. Moreover, most of the analysts on the PHH ignores the cost of mobility of translocation of pollution-intensive industries.

In addition to this, several previous empirical studies indicate that trade and FDI contribute to employment generation, income growth and technology upgrading in the developing countries. These changes may contribute to bring improvement in the environment. Similarly, there is also an empirical support to the stance that stringent environment regulations prompt environment-friendly technologies rather than only to contribute to relocation of the pollution-intensive industries.

Hence, the literature on the PHH indicates theoretical and empirical inconsistencies on the existence of the PHH. Moreover, scarce of the studies have examined the PHH in the EKC framework to find the environmental cost of economic growth especially in the ASEAN region.

2.7 Conclusion

This chapter concludes the theoretical and empirical literature on the PHH in three different sections. Section 2.2 critically reviews the impact of environmental regulations on the plant location of the industry. While, Section 2.3 reviews the literature about the role of trade for the environment specifically in developing countries. Moreover, Section 2.4 reviews the literature about the FDI and environment connection in line with the PHH. In addition, Section 2.5 evaluate the empirical literature about the EKC. Finally, Section 2.6 summarises the literature.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter aims to develop theoretical framework to examine the PHH in the context of the EKC. Theoretical framework depicts the relationship of independent and dependent variables and how they are interrelated to each other. The chapter includes six sections. Section 3.2 discusses the specification of the model to examine the PHH in the framework of the EKC for the ASEAN countries. Section 3.3 justifies the proposed variables of the model while, Section 3.4 explains the source of the data. Moreover, Section 3.5 describes the estimation technique to estimate the coefficients of the explanatory variables of the model. Finally, section 3.6 concludes the chapter.

3.2 Model

The EKC postulates a nonlinear relationship between income and pollution. According to the EKC hypothesis, at early phases of economic development, positive relation exists between economic growth and environmental degradation. As economic growth continuous, technology improves, and the share of services increases. These changes lead to the improvement of environment and relationship between income and pollution turns to be negative. To model this nonlinear relationship between income and pollution Dinda (2004) proposed following model.

$$Y_{it} = \beta_o + \beta_1 X_{it} + \beta_2 X^2{}_{it} + \mu_{it} \tag{3.1}$$

Where, Y_{it} is pollution and X_{it} is income. The EKC relation between income and pollution would exists if $\beta_1 > 0$ and $\beta_2 < 0$.

Prior literature indicates that pollution is determined by many factors other than income therefore, to avoid any model miss- specification two important determinants of pollution such as energy consumption (EC) and Foreign Direct Investment (FDI) are included in the equation 3.2 as control variables. The equation 3.2 and Figure 3.1 depicts the final EKC model.

$$Y_{it} = \beta_{\circ} + \beta_1 X_{it} + \beta_2 X_{it}^2 + \beta_3 EC_{it} + \beta_4 FDI_{it} + \mu_{it} \tag{3.2}$$

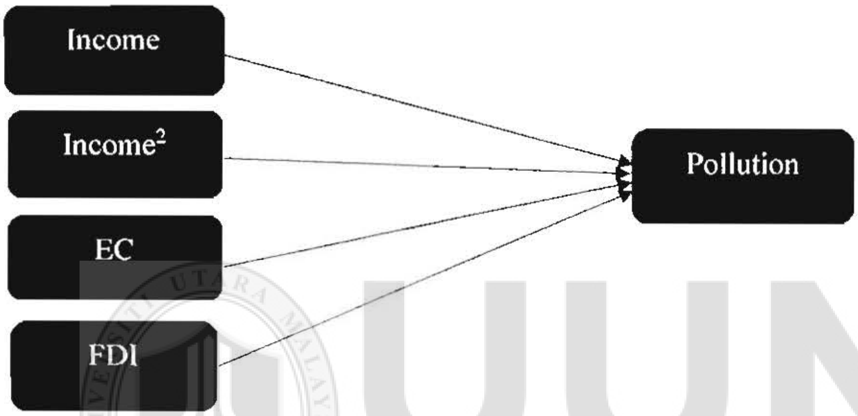

Figure 3.1
EKC Model

The PHH claims that following the free trade regime, advanced countries have specialized in clean goods production while developing countries have specialized in pollution-intensive goods production. The pollution in advanced countries has come down because they have shifted the pollution-intensive production process to the developing countries and have become the net importer of pollution-intensive goods from developing countries. Therefore, against the claim of the EKC hypothesis, the expansion in trade and economic activities have not led the pollution of the world to decrease, rather it has relocated it. To examine the impact of the PHH trade patterns on the EKC in the ASEAN countries, exports of pollution-intensive goods of the ASEAN countries to an advanced country Japan are included in the estimation of the EKC equation (3.3). The theoretical framework for this equation has been shown in Figure 3.2.

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 X_{it}^2 + \beta_3 EC_{it} + \beta_4 FDI_{it} + \beta_5 XDJA_{it} + \mu_{it} \quad (3.3)$$

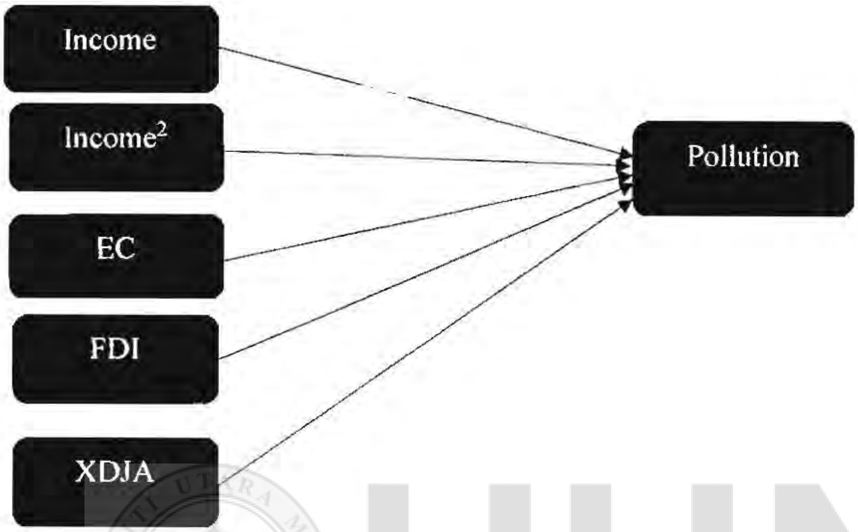

Figure 3.2
The PHH and EKC

Where, XDJA= export of pollution-intensive goods from the ASEAN to Japan. μ_{it} is error term that captures the variation of Y_{it} variable that is not explained by explanatory variables while i = 1.2.3......... n countries and t = 1.2.3.4.... t years.

The Equation (3.2) is used to examine inverted u-shaped (EKC) relationship between income and pollution. Some studies have used the logarithmic transformation of the model using ln(Y) and ln(X) as an alternative to Y and X (Stern, 2010). However, the choice of functional form depends on the availability of data and nature of the study.

The equation (3.3) is implied to examine the PHH effect in the context of the ASEAN countries in the EKC framework. If β_5 in the equation (3.3) is found positively significant, it can be interpreted that exports of pollution-intensive goods of the ASEAN to Japan are also responsible for the pollution in the ASEAN countries. The turning point of the EKC can be calculated by the following formula

$$\text{Turning Point Income level} = \frac{\beta_1}{2\beta_2} \qquad (3.4)$$

The comparison between the peak turning point of the EKC of the ASEAN countries calculated from the equation (3.2) where exports of pollution-intensive goods are supposed to affect the income environment relation implicitly and from the equation (3.3) where these exports have been included explicitly, would reveal how the PHH affect the slope of the EKC. This estimation will reveal how much production, specialization and exports of the pollution-intensive goods are responsible for the delay in the peak turning point of the EKC of the ASEAN countries. In other words, how much exports of pollution-intensive goods have contributed to the environmental cost of economic growth in the ASEAN countries.

Some scepticism may be developed about the implicit impact of the export of pollution-intensive on peak turning point of the EKC. The difference in peak turning point income level of the EKC from the equation (3.2) and from the equation (3.3) may be due to other factors then export of pollution-intensive goods. To overcome these uncertainties, the underlying study includes export of pollution-intensive goods in the model specification of the EKC interactively with income so that turning point will become context specific as suggested by (Rehman et al., 2012; Webber & Allen, 2004). This specification provides a way to empirically investigate the different turning points of the EKC corresponding to different level of exports of pollution-intensive goods. The equation (3.5) shows the extended model of the EKC by adding exports of pollution-intensive goods with income as an interaction term.

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 X_{it}^2 + \beta_3 (X * XDJA)_{it} + \beta_4 FDI_{it} + \beta_5 EC_{it} + \mu_{it} \qquad (3.5)$$

Figure 3.3 depicts how exports of pollution-intensive goods affect the income environment - relation based on the equation 3.5.

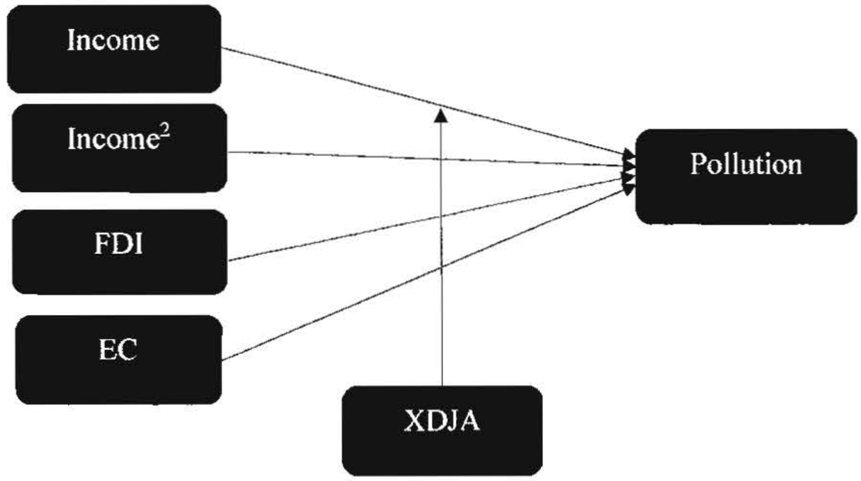

Figure 3.3
Impact of export of pollution-intensive exports from the ASEAN to Japan on the EKC

The interaction term now has following interpretations. Given the income level, pollution will increase with the increase in exports of pollution-intensive goods. Similarly, given the level of exports, pollution will rise due to increase in income. To determine the interaction term effect in this model, Wald test for zero restriction of the parameter for interaction term has been implied.

In the Equation (3.5) exports of pollution-intensive goods affect the pollution indirectly by affecting the economic growth and economic growth affects the environment. This indirect effect is assumed to influence the turning point of the EKC owing to its effect on GDP. This specification is very important in terms of tracing out the true impact of the PHH on the turning point of the EKC. According to Aubourg et al. (2008), this model allows to locate the turning point GDP values inclusive of exports indicators. With this specification, the formula for determining the GDP per capita at the turning point will be as follow.

Turning Point Income level $= \frac{\beta_1 + \beta_3 XDJA_{it}}{2\ \beta_2}$ (3.6)

The peak turning point per capita income level of the EKC in the equation (3.6) has become dependent on the export of pollution-intensive goods from the ASEAN to Japan. By assuming different values of exports of pollution-intensive goods from the ASEAN to Japan, the peak turning income level of the EKC can be calculated corresponding to these exports levels.

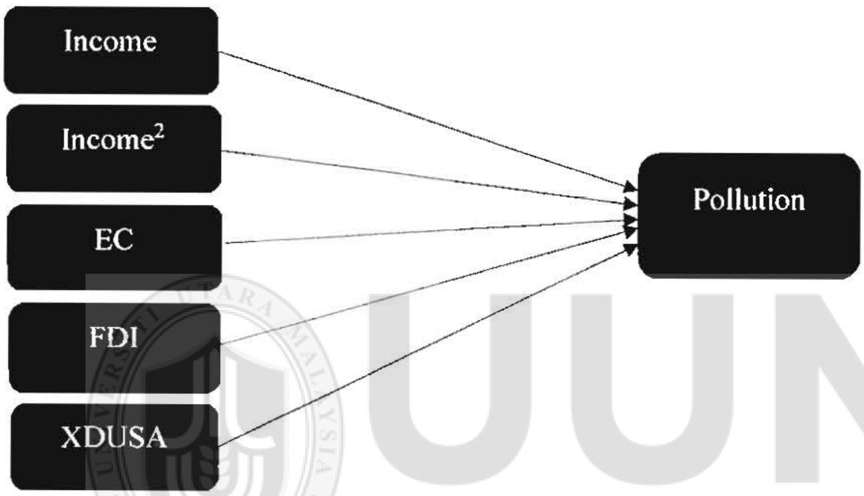

Figure 3.4
The PHH and the EKC

Similar model specification can be made to examine the impact of the export of pollution-intensive goods from the ASEAN to the USA as shown in the equation (3.7) and in Figure 3.4.

$$Y_{it} = \beta_\circ + \beta_1 X_{it} + \beta_2 X_{it}^2 + \beta_3 EC_{it} + \beta_4 FDI_{it} + \beta_5 XDUSA_{it} + \mu_{it} \quad [3.7]$$

Here XDUSA= exports of pollution-intensive goods from the ASEAN to the USA.

Similarly, the XDUSA can be taken as interaction term with income to trace out its true impact on the EKC turning point as shown in the equation [3.8] and in Figure 3.5.

$$Y_{it} = \beta_\circ + \beta_1 X_{it} + \beta_2 X_{it}^2 + \beta_3 (X * XDUSA)_{it} + \beta_4 FDI_{it} + \beta_5 EC_{it} + \mu_{it} \quad [3.8]$$

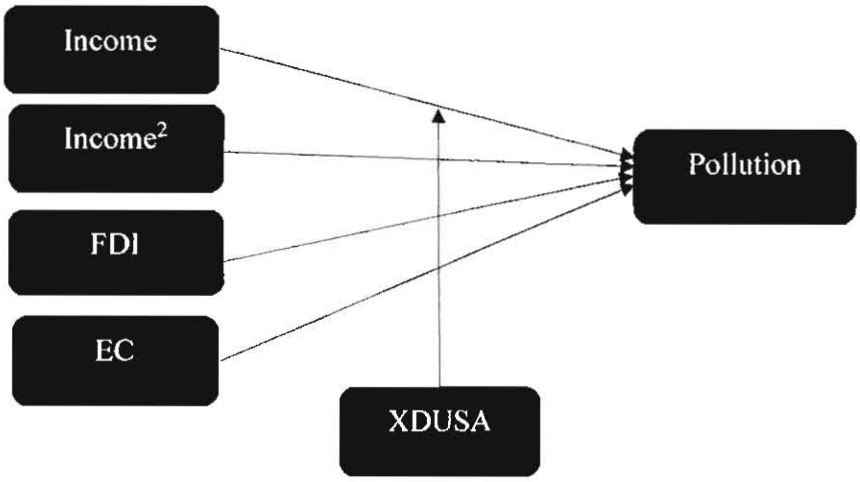

Figure 3.5
Impact of exports of pollution-intensive goods from the ASEAN to the USA on the EKC

Moreover, the turning point income level of the EKC can be calculated in similar way as given in the equation (3.9).

$$\text{Turning Point Income level} = \frac{\beta_1 + \beta_3 XDUSA_{it}}{2\ \beta_2} \qquad (3.9)$$

3.3 Justification of the Variables

The main objective of the study is to determine the role of the trade of pollution-intensive goods in an income-environment relationship in the context of the ASEAN countries. For this purpose, the variables that represent pollution, income and pollution-intensive goods have been included in the study. To avoid any misspecification of the model, two important determinants of pollution namely, foreign direct investment (FDI) and energy consumption (EC) also have been included as a control variable.

3.3.1 Pollution

To measure the pollution, CO_2 emission as a proxy of pollution has been taken as per practice in the EKC and the PHH literature. Pollution is a wide term and the empirical studies on the EKC and the PHH have used air pollutants like Corban Dioxide (CO_2), Sulphur Dioxide (SO_2) and Particulate Matter (PM_{10}) as a measure of pollution. However, majority of the studies on the EKC and on the PHH have used CO_2 as a measure of pollution owing to availability of the data. The studies like (Hassaballa, 2013; Kivyiro & Arminen, 2014) provided logical justification for the use of CO_2 emission as a measure of pollution. They stated that CO_2 is a primary source of global warming and highly correlated with local pollutants like Sulphur Dioxide and Nitrogen Oxide. In addition, CO_2 is also a major determinant of Green House Gases (GHG) and is the main contributor to the environmental changes taking place around the globe.

3.3.2 Income

GDP per capita has been taken as measure of income as per the practice of EKC and the PHH studies. This study has discussed earlier that relationship between income and environment degradation in the EKC framework is nonlinear, increasing in the first phase and decreasing in the second phase. the coefficient on the GDP per capita must be positive significant and on squared of GDP per capita coefficient must be negative significant. Studies like (Coondoo & Dinda, 2008; De Bruyn, 1997; Jaunky, 2011; Kwiatkowski et al., 1992; Panayotou, 2000; Richmond & Kaufmann, 2006) found positive significant sign with income per capita and negative significant with square term of per capita income therefore, provided an empirical support to the EKC hypothesis. While, the studies like (C.-C. Lee & Lee, 2009; Moomaw & Unruh, 1997) found N- shaped relationship between income and environment. However, the studies like (Egli, 2002; Vuokko Lantz & Feng, 2006) did not find any support to the EKC relation between income and environment.

3.3.3 Exports of Pollution Intensive Goods

The underlying study uses export of pollution-intensive goods from the ASEAN to Japan (XDJA) and to the USA (XDUSA) to examine the existence of the PHH in the ASEAN countries. The exports of four goods (chemical, plastic, paper and pulps and woods) are assumed to use the most environmental resources. Moreover, these industries have most pollution-intensive production process therefore, current study has selected these studies for analysis.

The studies are plentiful such as Ziaoling (2008), Kiuila (2015), Suns and Lau (2013) and Keho (2016) that examine the relationship between trade and pollution and have diverse outcomes. However, limited studies have examined the impact of exports of pollution-intensive goods on pollution and on income environment relation. Following the literature about trade environment relation, the coefficient on exports of pollution-intensive goods can be positive as well as negative.

3.3.4 Control variables

Two control variables FDI and energy consumption (EC) have been included in the EKC model to avoid any possible misspecification of the model. FDI is considered as a one of the important determinants of the pollution in the literature of environmental economics. Two conflicting views exist in the literature about the impact of FDI on the pollution namely, Halo Effect Hypothesis and the PHH. Halo claims that FDI spurs economic growth, leads to technological up-gradation and to positive environment spill over. These changes eventually lead to decrease the pollution in long run (Albornoz et al., 2009). While, the PHH postulates that FDI makes the environment of the developing countries more worse. (Cole & Elliott, 2005; Cole et al., 2006). The empirical and theoretical literature has mixed outcome about the impact of FDI on pollution in host countries (Xing & Kolstad, 2002; Zarsky, 1999).

Previous literature indicates that energy consumption (EC) is another important determinant of pollution. The studies are numerous such as (Ang, 2007b; Apergis & Payne, 2009; Halicioglu, 2009b; Kivyiro & Arminen, 2014; Richmond & Kaufmann, 2006) that have included energy consumption while testing the link between economic growth and environment.

3.4 Data

This study uses time series data for the six ASEAN countries for the period 1989 to 2014. Depending upon the availability of data, the analysis is confined to only six ASEAN countries namely Singapore, Malaysia, Indonesia, Thailand, Vietnam and Philippine. As per usual practice in the EKC and the PHH literature, CO_2 emission in 'metric ton' has been taken as a measure of environmental degradation and GDP per capita as a measure of income. The data for CO_2 emission has been taken from the report of International Energy Statistics 2016. While the per capita GDP data has been obtained from the World Economic Outlook 2016. Data about FDI and energy consumption (measured in kg of oil equivalent per capita) have been collected from World Development Indicator 2015. The pollution-intensive goods include those goods that have the most polluted production process. In the context of this study chemical, plastic, paper and pulp and wood industries are taken as most pollution-intensive industries. The export data of these goods from the ASEAN to two advanced countries (the USA, Japan) have been taken from World Trade Statistics (WTS,2017). The USA and Japan have been major trade partners of the ASEAN countries for the last three decades.

3.5 Method of Analysis

The underlying study examines the PHH in the EKC framework for the panel of six major ASEAN countries for the period 1989 to 2014. Therefore, panel estimation techniques have been employed to estimate the coefficients of the model. The study uses time series data of 25 years and there is every chance that variables may not be stationary over the time, that is the violation of one of the important assumptions of the ordinary least square (OLS). The study therefore, uses panel cointegration technique for the analysis of the time series data.

3.5.1 Panel Data Analysis

The panel cointegration data analysis consists of the four steps. First, the stationarity properties of the time series variables are examined using alternative panel unit root tests. If proposed variables are non-stationary, the second step is to test whether there is cointegration relationship between the series, using appropriate panel cointegration techniques. The presence of cointegration in first three models will lead to estimate the long run elasticities by utilizing fully modify OLS (FMOLS).

3.5.2 Panel Unit Roots

It is the one of the important assumption of the Ordinary Least Square (OLS) that time series variables must be stationary. They must be independent of the time. The non-stationary time series usually lead to spurious regression. The coefficients appear to be significant when they are not. Similarly, they appear to be insignificant when they are significant. Testing the stationarity properties of time series variables therefore, is an important pre-requisite for panel regression analysis.

A stationary time series variable is defined as one that comprises statistical properties like constant mean, median, variance and is independent of the time. In other words, data in this time series fluctuate around a constant mean. The variance of the fluctuation always remains constant over time. The mean and variance of the data series during a year will be different from another year. If the initial time series is not stationary, there is a need for some transformation to make it stationary.

The traditional unit root tests are too limited to determine the stationarity properties of the variables in panel settings; therefore, new unit root tests have been developed for the purpose (Martin *et al.* 2013). There are several panel unit root test such as Im et al. (2003) test is called IPS; Levin, Lin, and James Chu (2002) known as LLC and Maddala and Wu (1999) shortly called MW to examine the stationarity properties of the variables. These tests are applied to balanced panel, nevertheless, the LLC can be considered a pooled panel unit root test and the IPS represents as a heterogeneous panel test while, MW panel unit root test is non-parametric test.

Although, there are several panel unit root tests, yet this study applies IPS and LLC unit root tests suggested by Im et al. (2003) due to various advantages of these tests. These tests explore a panel unit root in the context of a heterogeneous panel that is a more optimal assumption of a panel unit root test.

The IPS test is not as restrictive as the LLC test. It allows for heterogeneous coefficient and proposes an alternative testing procedure based on averaging individual unit root test statistics. IPS suggests an average of the Augmented Dicky Fuller (ADF) tests when error term of the regression μ_{it} is consecutively connected across cross-sectional units with different serial correlation properties. The null hypothesis (H_0) is that each series in the panel contains a unit root like $H_0 : \rho_i = 0$ for all i and the alternative hypothesis (H_1) allows for some (but not all) of the individual series to have unit root;

$$H_1: \{\rho_i < 0\, for\ i + 1,2,\ldots, N_1\ and\ \rho_i = 0\, for\ i = N_1 + 1, \ldots, N\} \tag{3.10}$$

Formally, it needs that the fraction of the individual time series that are stationary to be nonzero, like $\lim_{n\to\infty}(n1/n) = \delta\ where\ 0 < \delta \leq 1$. This is the pre-requisite for a panel unit root to be consistent. The IPS t-bar statistic ($\bar{t}$) is defined as the average of the individual ADF statistics. as explained in the equation (3.11).

$$\bar{t} = \frac{1}{N} \sum_{i=1}^{N} t_{\rho i} \tag{3.11}$$

To test the null hypothesis $\rho_i = 0$ for all I t_{ρ_i} is the individual t-statistics. The IPS panel unit root test provides simulated critical values for $\bar{t}$ different number of cross-section n, series length T. Dickey-Fuller (DF) regressions containing intercepts only or intercepts and linear trends. In the general case where the lag order ρ_i may be nonzero for some cross-sections, IPS shows that a properly standardized $\bar{t}$ has an asymptotic $N(0, 1)$ distribution. Starting from well-known results in the time series that for a fixed n.

$$t_{\rho i} \Longrightarrow \frac{\int_0^1 W_{iz} dW_{iz}}{\left[\int_0^1 W_{iz}^2\right]^{\frac{1}{2}}} = t_{iT} \tag{3.12}$$

as $T \to \infty$, where $\int W(r)\,dr$ denotes a Weiner integral with the argument r suppressed in the Equation (3.11), IPS assumes that t_{iT} are IID and have finite mean and variance, represented in the Equation (3.12).

$$\frac{\sqrt{n}\left(\frac{1}{n}\sum_{i=1}^{n} t_{iT}-\frac{1}{n}\sum_{i=1}^{n} E[t_{iT}\,|\rho_i=0]\right)}{\sqrt{\frac{1}{n}\sum_{i=1}^{n} var\,[t_{iT}|\rho_i=0]}} \Rightarrow N(0,1) \tag{3.13}$$

as $n \to \infty$ by the Lindeberg –Levy central limit theorem, the Equation (3.13) converted into the Equation (3.14).

$$\frac{\sqrt{n}\left(\bar{t}-\frac{1}{n}\sum_{i=1}^{n} E[t_{iT}\,|\rho_i=0]\right)}{\sqrt{\frac{1}{n}\sum_{i=1}^{n} var\,[t_{iT}|\rho_i=0]}} \Rightarrow N(0,1) \tag{3.14}$$

as $T \to \infty$ followed by $n \to \infty$ sequentially. The values of $E\left[t_{iT}\middle|\rho_i = 0\right]$ and $VAR\left[t_{iT}\middle|\rho_i = 0\right]$ have been computed by IPS via simulations for different values of T and ρ_i's.

3.5.3 Panel Cointegration Tests

The cointegration approach tests the relationship between long-run equilibrium and the non-stationary economic variables. Let us consider, X_t be a vector of variables integrated of order one $I(1)$. Then the variables of X_t are deemed cointegrated if and only if, the linear combination $\beta' X_t$ (with $\beta \neq 0$) is stationary ($\beta' X_t \sim I(0)$) or the equilibrium error process is stationary ($U_t = Y_t - \beta' X_t$). The equilibrium is meaningful when the equilibrium error process is stationary (Engle & Granger, 1987). In literature, variety of econometric methodologies have been offered to evaluate long-run equilibrium relationship between non-stationary time series variables.

The residual-based cointegration test proposed by Engle and Granger (1987) and Johansen (1995) cointegration methods have been frequently used in literature to examine the long-run equilibrium relationship among the variables. Before running any estimation, it is the prerequisite of above methods that variables must follow the same order of integration.

Johansen (2002) observed that traditional cointegration approaches provide unreliable results for small sampling. However, panel cointegration tests like Kao (1999), Maddala and Wu (1999), (Pedroni, 1999a, 2004) and Westerlund (2007) provide reliable estimates. This study therefore, uses Kao (1999) and (Pedroni, 1999a, 2004) cointegration tests because of various advantages of these tests.

Kao (1999) explained two different cointegration tests namely, Dicky Fuller (DF) and Augmented Dicky Fuller (ADF) for the variables of panel data.

The Equation (3.15) consider the following regression for panel data.

$$y_{it} = x'_{it}\beta + z'_{it}\gamma + \varepsilon_{it} \tag{3.15}$$

where y_{it} and x_{it} are integrated of order I (1) and non-cointegrated. For $z_{it} = \{\mu_i\}$, Kao (1999) proposed DF and ADF unit root tests for ε_{it} as a test for the null of no cointegration. The DF-type tests can be calculated from the fixed effects residuals as shown in the Equation (3.16).

$$e'_{it} = \rho \hat{e}_{i,t-1} + v_{it} \tag{3.16}$$

where $e'_{it} = \tilde{y}_{it} - \tilde{x}'_{it}\hat{\beta}$ and, $\tilde{y}_{it} = y_{it} - \bar{y}i$ $\tilde{x}_{it} = x_{it} - \bar{x}i$. The null hypothesis can also be written as $H_0 : \rho = 1$ to examine the null hypothesis of no cointegration. The estimates of OLS for t-statistics and for ρ are given as

$$\hat{\rho} = \frac{\sum_{i=1}^{N}\sum_{t=2}^{T}\hat{e}_{it}\ \hat{e}_{i,t-1}}{\sum_{i=1}^{N}\sum_{t=2}^{T}\hat{e}_{it}} \tag{3.17}$$

and

$$t_p = \frac{(\hat{\rho}-1)\sqrt{\sum_{i=1}^{N}\sum_{t=2}^{T}\hat{e}_{it}\ \hat{e}_{i,t-1}}}{s_e} \quad (3.18)$$

where

$$s_e^2 = \frac{1}{NT}\sum_{i=1}^{N}\sum_{t=2}^{T}\left(\hat{e}_{it} - \hat{\rho}\hat{e}_{i,t-1}\right)^2 \quad (3.19)$$

Kao proposed the following four of ADF tests as shown by the Equation (3.20) to the Equation

$$DF_\rho = \frac{\sqrt{NT}\left(\hat{\rho}-1\right)+3\sqrt{N}}{\sqrt{10.2}} \quad (3.20)$$

$$DF_t = \sqrt{1.25}\cdot t_\rho + \sqrt{1.875N} \quad (3.21)$$

$$DF_\rho^* = \frac{\sqrt{NT}\left(\hat{\rho}-1\right)+\frac{3\sqrt{N}\hat{\sigma}_v^2}{\hat{\sigma}_{\sigma v}^2}}{\sqrt{3+\frac{36\hat{\sigma}_v^4}{5\hat{\sigma}_{\sigma v}^4}}} \quad (3.22)$$

$$DF_t^* = \frac{t_\rho + \frac{\sqrt{6N}\hat{\sigma}_v}{2\hat{\sigma}_{\sigma v}}}{\sqrt{\frac{\hat{\sigma}_{\sigma v}^2}{2\hat{\sigma}_v^2}+\frac{3\hat{\sigma}_v^2}{10\hat{\sigma}_{\sigma v}^2}}} \quad (3.23)$$

where, and $\hat{\Sigma}$ is estimator of long-run covariance of and the estimator of contemporaneous covariance $\zeta_{it} = (\Delta y_{it}, \Delta x'_{it})'$. While, DF_ρ and DF_t are based on the strong exogenity of the disturbance terms and regressors. The following regression for the ADF test can be run as shown in the Equation (3.24)

$$\hat{e}_{it} = \rho\hat{e}_{i,t-1} + \sum_{j=1}^{P}\delta_j\Delta\hat{e}_{i,t-j} + v_{it} \quad (3.24)$$

The statistics for ADF can be established as follow with null hypothesis (H_o) of no cointegration:

$$ADF = \frac{t_{ADF} + \frac{\sqrt{6N}\hat{\sigma}_v}{2\hat{\sigma}_{ov}}}{\sqrt{\frac{\hat{\sigma}_{ov}^2}{2\hat{\sigma}_v^2} + \frac{3\hat{\sigma}_v^2}{10\hat{\sigma}_{ov}^2}}} \tag{3.25}$$

where t_{ADF} is the t-statistic of ρ in the Equation (3.25). The asymptotic distribution of DF_ρ, DF_t, DF_t^*, DF_ρ^* and ADF converge to a standard normal distribution N (0, 1) by sequential limit theory.

Several panel cointegration tests have been proposed by Pedroni (1999, 2004). The main advantage of these tests is that they allow substantial heterogeneity among the different sections. Pedroni (1999) suggested the following regression equation:

$$y_{it} = \alpha_i + \delta_i t + X'_{it}\beta_i + e_{it} \tag{3.26}$$

Here y_{it} and x_{it} are time series panel variables with members i=1......n and time periods t=1......T. Moreover, x_{it} and β_i are a m-dimensional vectors for each identity in the panel. Moreover, it is assumed that variables y_{it} and x_{it} for each identity i in the panel are integrated of order I(1). In addition, the error term e_{it} is also assumed of integrated order I(1) under the null hypothesis of no cointegration. The coefficients α_i and δ_i are also permitted to adjust possible identity specific fixed effects and deterministic effects separately. Moreover, to ensure that cointegration vectors may be heterogeneous across all the identities in the panel, these coefficients are also allowed to change by each identity. The ADF and DF tests statistics can be calculated by residuals of the fixed effects as shown in the equation (3.27) and (3.28)

$$\hat{e}_{it} = \rho_i \hat{e}_{i,t-1} + v_{it} \tag{3.27}$$

$$\hat{e}_{it} = \rho_i \hat{e}_{i,t-1} + \sum_{j=1}^{P} \varphi_{ij} \Delta \hat{e}_{i,t-j} + v_{it} \tag{3.28}$$

The null hypothesis for cointegration tests are:

$H_0 : \rho_i = 1; H_1 : \rho_i = \rho < 1 \;\; (i = 1,2,...,N)$

and

$H_0 : \rho_i = 1; H_1 : \rho_i < 1 \;\; (i = 1,2,...,N)$

To study the distribution properties of above tests, Pedroni described the DGP in terms of the partitioned vector $Z'_{it} = (Y_{it}, X'_{it})$ such that the true process Z_{it} is generated as

$Z_{it} = Z_{i,t-1} + \xi_{it}$ for $\xi'_{it} = (\xi^Y_{it}, \xi^x_{it})$.

The tests suggested by Pedroni (1999, 2004) can divided in two categories. The first category (within dimension) contains the average of the time series co-integration test statistics of all identities in the panel as has been discussed above. While in the second category (between dimension) the limiting distributions are grounded on the limits of piecewise numerator and denominator terms therefore the averaging is done in pieces.

However, both categories estimate hypothesized co-integration relationship separately for each identity in the panel and then aggregate the all the residuals while, establishing the panel test statistics for the null hypothesis (H_0) of no co-integration among the variables in the panel.

Precisely, using the Equation (3.15) in the first step, the suggested co-integration regression is estimated for each identity in the panel. Moreover, idiosyncratic intercepts are also included to attain the corresponding residual $\hat{e}_{it}$ as per the co-integrating model warrants. The estimated pooled residuals differ among different statistics in the second step (Maddala & Kim, 1998). It is defined as shown in following the equations.

Panel Variance Ratio Statistics

$$Z_{\hat{v}_{NT}} = \hat{L}_{11}^{2}\left(\sum_{i=1}^{N} A_{22i}\right)^{-1} = \hat{L}_{11}^{2}\left(\sum_{i=1}^{N}\sum_{t=1}^{T} e_{i,t-1}^{2}\right)^{-1} \tag{3.29}$$

Panel- rho statistic:

$$\begin{aligned} Z_{\hat{\rho}_{NT}-1} &= \left(\sum_{i=1}^{N} A_{22i}\right)^{-1}\left(\sum_{i=1}^{N}\left(A_{21i} - T\hat{\lambda}_i\right)\right) \\ &= \left(\sum_{i=1}^{N}\sum_{t=1}^{T} e_{i,t-1}^{2}\right)^{-1}\left[\sum_{i=1}^{N}\sum_{t=1}^{T}\left(\Delta\hat{e}_{it}\hat{e}_{i,t-1} - \hat{\lambda}_i\right)\right] \end{aligned} \tag{3.30}$$

Panel-t statistic:

$$\begin{aligned} Z_{t_{NT}} &= \left(\tilde{\sigma}_{NT}^{2}\sum_{i=1}^{N} A_{22i}\right)^{-1/2}\left[\sum_{i=1}^{N}\left(A_{21i} - T\hat{\lambda}_i\right)\right] \\ &= \left(\tilde{\sigma}_{NT}^{2}\sum_{i=1}^{N}\sum_{t=1}^{T} e_{i,t-1}^{2}\right)^{-1/2}\left[\sum_{i=1}^{N}\sum_{t=1}^{T}\left(\Delta\hat{e}_{it}\hat{e}_{i,t-1} - \hat{\lambda}_i\right)\right] \end{aligned} \tag{3.31}$$

Group-rho Statistic:

$$\tilde{Z}_{\hat{\rho}_{NT}-1} = \sum_{i=1}^{N} A_{22i}^{-1}\left(A_{21i} - T\hat{\lambda}_i\right) = \sum_{i=1}^{N}\left[\left(\sum_{t=1}^{T} e_{i,t-1}^{2}\right)^{-1}\sum_{t=1}^{T}\left(\Delta\hat{e}_{it}\hat{e}_{i,t-1} - \hat{\lambda}_i\right)\right] \tag{3.32}$$

Group-t statistic:

$$\tilde{Z}_{t_{NT}} = \sum_{i=1}^{N}\left[\left(\hat{\sigma}_i^{2}\sum_{t=1}^{T} e_{i,t-1}^{2}\right)^{-1/2}\left[\sum_{t=1}^{T}\left(\Delta\hat{e}_{it}\hat{e}_{i,t-1} - \hat{\lambda}_i\right)\right]\right] \tag{3.33}$$

While, $\hat{\mu}_{it} = \hat{e}_{it} - \hat{\rho}_i\hat{e}_{i,t-1}$, $\hat{\lambda}_i = \frac{1}{T}\sum_{s=1}^{K_i} w_{sK_i}\sum_{t=s+1}^{T}\hat{\mu}_{it}\hat{\mu}_{i,t-s}$ for some choice of lag window.

$w_{sk_i} = 1 - \frac{s}{1+K_i}$, $\hat{S}_i^2 = \frac{1}{T}\sum_{i=1}^{K_i}\hat{\mu}_{it}^2$, $\tilde{\sigma}_i^2 = \hat{S}_i^2 + 2\hat{\lambda}_i^2$, $\tilde{\sigma}_{NT}^2 = \frac{1}{N}\sum_{i=1}^{N}\hat{\sigma}_i^2$, and $\hat{L}_{11}^2 = \frac{1}{N}\sum_{i=1}^{N}\hat{\sigma}_i^2$, where

$\hat{L}_{11i}^2 = \left(\hat{\Omega}_{11i} - \hat{\Omega}_{21i}\hat{\Omega}_{22i}^{-1}\hat{\Omega}_{21i}\right)$ such that $\hat{\Omega}_i$ is consistent.

The first three statistics are based on pooling the data across the within dimension of the panel. This means that these statistics are established by adding the denominator and numerator terms separately for the similar time series statistics.

The remaining two statistics can be constructed by pooling the data along the between dimension of the panel. This means that these statistics can be constructed by computing the ratio first corresponding to the conventional time series statistics. Later, the standardized sum of the whole ratio is computed. As a result, these statistics compute the group average of the individual time series statistics.

In case of multiple regressions Pedroni (1999a) had derived critical values and asymptotic distributions for several residual-based tests developed for panel data to tests the null of no cointegration.

Let consider the Equation (3.34).

$$\frac{\chi_K - \mu_K\sqrt{N}}{\sqrt{V_K}} \Rightarrow N(0,1) \quad (as\ T, N \to \infty)_{seq} \tag{3.34}$$

where

$$\chi = \left(T^2 N^{3/2} Z_{\hat{\nu}_{NT}}, T\sqrt{N} Z_{\hat{\rho}_{NT}-1}, Z_{t_{NT}}, TN^{-1/2}\tilde{Z}_{\hat{\rho}_{NT}-1}, N^{-1/2}\tilde{Z}_{t_{NT}}\right)'$$

The critical values of the μ_k and V_k can be found from the table Pedroni (1999a) for each of the K=1....5 statistics of X. It depends on whether the model contains the estimates about fixed effects and estimated trends. Therefore, to examine the null hypothesis of no co-integration, one simple computes the values of the statistic so that it is in the form of the Equation (3.15) and is based on the value of μ_k and V_k from the table II in Pedroni (1999) and compares these to the appropriate tails of the normal distribution.

The statistics of panel variance diverges to positive infinity under the alternate hypothesis. Resultantly, the right tail of the normal distribution is employed to reject the null hypothesis of no cointegration. The large positive statistics of panel variance indicate that null hypothesis of no co-integration is rejected.

For each of the other four test statistics, these diverge to negative infinity under the alternative hypothesis, and consequently the left tail of the normal distribution is used to reject the null hypothesis. Hence, for any of these latter tests, large negative values imply the null of no cointegration is rejected.

3.5.4 Panel Fully Modified Ordinary Least Square Estimation (FMOLS)

The panel unit root test is pre-requisite of the FMOLS. The panel unit root confirms that all the variables must either stationary at level I (0) or stationary at first difference I (1). After determining the order of the cointegration, next step is to establish the existence of cointegrating relationship among the time series variables. Having established the cointegration relation among the time series variables in the long run, next step is to estimate the long run cointegration relation. The study uses the Fully Modify OLS (FMOLS) method proposed by (Pedroni, 2001). It allows for estimating heterogeneous cointegrated vector for panels members. The main advantage of this method is that it corrects for both serial correlation and simultaneity bias. Pedroni (2001) considered the following cointegrated system for panel data:

$$Y_{it} = \alpha_i + \beta X_{it} + \varepsilon_{it} \tag{3.35}$$

where Y_{it} and X_{it} are cointegrated. Pedroni (2001) proposed another equation that augments the cointegrating regression with lead and lagged differences of the regressors to control the endogenous feedback effect. Hence, the Equation (3.35) is specified as:

$$Y_{it} = \alpha_i + \beta X_{it} + \sum_{k=-ki}^{Ki} \gamma_{ik} \Delta X_{it-k} + \varepsilon_{it} \tag{3.36}$$

Pedroni (2001)also defines $\varsigma_{it} = (\varepsilon_{it}, \Delta X_{it})$ and let $\Omega_{it} = \lim E[1/T(\sum_{t=1}^{T} \varsigma_{it})(\sum_{t=1}^{T} \varsigma_{it})']$ is the long run covariance for this process. This long-run covariance matrix can be decomposed as $\Omega_i = \Omega_i^0 + \Gamma_i + \Gamma_i'$ where Ω_i^0 is the contemporaneous covariance and Γ_i is a weighted sum of autocovariance. Hence, the panel FMOLS estimator is specified as follows:

$$\beta^{*}_{FMOLS} = \frac{1}{N} \sum_{i=1}^{N} \left[\left(\sum_{t=1}^{T} (X_{it} - \overline{X}_i)^2\right)^{-1} \left(\sum_{t=1}^{T} (X_{it} - \overline{X}_i) Y^{*}_{it} - T\gamma_i\right) \right] \tag{3.37}$$

where $Y^{*}_{it} = Y_{it} - \overline{Y}(\hat{\Omega}_{2,1,i} / \hat{\Omega}_{2,2,i}) \Delta X_{it} and \hat{\gamma}_i = \hat{\Gamma}_{2,1,i} + \hat{\Omega}^0_{2,1,i} - (\hat{\Omega}_{2,1,i} / \hat{\Omega}_{2,2,i})(\hat{\Gamma}_{2,2,i} + \hat{\Omega}_{2,2,i})$

3.6 Conclusion of the Chapter

The current chapter elucidates the research methodology that employs in the current study. Moreover, it discusses the model specification to estimate the EKC and the PHH. In addition, the current chapter also defines and justifies the inclusion of the study variables and data sources. Furthermore, it also highlights the estimation methodology employed in the current study to determine long run relationship in panel settings.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter details the empirical results and implications of the current study. The empirical results are devided in two catagories. The Section 4.2 presents the results of the first analysis that is carried out to examine the impact of specialization and export of pollution-intensive goods from the ASEAN to Japan on pollution in the ASEAN countries. While Section 4.3 explains the results of the second analysis that is carried out to investigate the impact of specialization and export of pollution-intensive goods from the ASEAN to the USA on polltion in the ASEAN countries. Lastly, Section 4.4 concludes the chapter.

4.2 Results and Discussion of the First Analysis

This analysis aims to investigate the presence of the PHH in the ASEAN countries in EKC framework. Moreover, it also assesses the extent to which the exports of pollution-intensive goods from the ASEAN to Japan contributes to the skewed slope of the EKC of the ASEAN countries. For this purpose, the Fully Modified Ordinary Least Square FMOLS has been employed to estimate the coefficients of the independent variables. The analysis includes descriptive statistics that describe the characteristics of the variables, panel unit root tests statistics that diagnose stationarity properties of the variables, panel co-integration tests statistics that investigate long-run cointegration relationship among the variables and finally FMOLS that estimates co-integration relationship.

4.2.1- Descriptive Statistics

Descriptive statistics describe basic features of the data whether it is cross-sectional, time series or panel. Moreover, they also describe the degree of the variation of the variables. Descriptive statistics are grouped into two categories: (i) measures of central tendencies (mean, median and mode); (ii) measures of dispersion (standard deviation (S.D), minimum and maximum values variables, kurtosis and skewness). Table 4.1 reveals the descriptive statistics of the variables that have been included in the EKC model. The maximum CO_2 emission is observed at 641 $MtCO_2$[20] in Indonesia in 2014 while minimum CO_2 emission is observed 13.47 $MtCO_2$ in Singapore in 2010. The mean value of 147 with 125 standard deviation indicates large amount of the variation in CO_2 emission in the region.

Table 4.1
Descriptive Statistic

Variables	CO_2	X	EC	FDI	XDJA
Mean	147	7125	1697	7.58E+09	1729145
Median	104	2356	845	3.84E+09	1235932
Maximum	641	56010	7370	6.85E+10	7448320
Minimum	13.47	97.2	269	-4.55E+09	0.00
S.D	125	11852	1679	1.18E+10	1607783
Skewness	1.59	2.57	1.42	3.246102	1.41
Kurtosis	5.93	9.26	3.90	14.54442	4.65
Jarque-Bera	122	427	58.1	1140.246	69.5
Observations	156.	156	156	156	156

Similarly, GDP per capita (X) also displays substantial variation. Maximum GDP per capita is noted at 56010$ of Singapore in 2014 while, minimum GDP per capita was 97.2$ of Vietnam

[20] $MtCO_2$ = 1 million tonnes of CO_2

in 1989. Moreover, significant variation is also observed in the exports of pollution-intensive goods (XDJA) from ASEAN to Japan and in energy consumption (EC) as evinced by their large values of S.D with respect to mean values. However, FDI inflows have been consistent as compared to other variables. Difference between large and small values of the FDI is not as large as of the other variables. It indicates that the ASEAN countries have consistently received the FDI inflows.

4.2.2 Correlation Statistics

Correlation analysis highlights how much variables are related to each other. This information is useful to avoid the problem of multicollinearity in regression analysis. Table 4.2 details the correlation statistics among the proposed variables. According to the results, the explanatory variables GDP per capita (X), EC, FDI and XDJA are not as highly correlated to each other as they can disturb the BLUE[21] properties of the model.

Table 4.2
Correlation Matrix

Variables	CO_2	X	X^2	EC	FDI	XDJA
CO_2	1.000	-0.293	-0.293	-0.240	-0.003	-0.544
X	-0.293	1.000	0.946	0.850	0.853	0.337
X^2	-0.293	0.946	1.000	0.653	0.890	0.372
EC	-0.240	0.850	0.653	1.000	0.590	0.180
FDI	-0.003	0.853	0.890	0.590	1.000	0.531
XDJA	-0.544	0.337	0.372	0.180	0.531	1.000

[21] BLUE properties imply that coefficients of the model are best, linear, unbiased and efficient

4.2.3 Unit Roots Test

The precondition using panel cointegration tests is to decide whether the time series variables in the panel have a unit root problem. Levin, Lin, and Chu (2002)(LLC) and Im and Pesaran (2003)(IPS) tests for each time series variable are summarized in Table 4.3. The test statistics of LLC and IPS fail to reject the null hypothesis that all the variables in the panel are non-stationary. However, at first difference, all the variables become stationary and test statistics reject the null hypothesis. Hence, it can be concluded that all the variables in the panel are integrated of order I (1).

Table 4.3
Results of Panel Unit Root Tests

	LLC	**IPS**		
Variable	**Level**	**First Difference**	**Level**	**First Difference**
CO_2	2.09	-10.36	4.05	-9.26
	[1.00]	[0.00] *	[1.00]	[0.00] *
X	7.13	-5.54	8.07	-4.1
	[1.00]	[0.00] *	[1.00]	[0.02] **
X^2	6.69	-1.97	6.67	-1.27
	[1.00]	[0.02] **	[1.00]	[0.10] ***
FDI	3.72	-9.59	4.43	-12.19
	[0.99]	[0.00] *	[0.99]	[0.00] *
EC	0.52	-8.47	0.51	-7.84
	[0.70]	[0.00] *	[0.70]	[0.00] *
XDJA	5.55	-2.81	5.19	-3.59
	[1.00]	[0.002] *	[1.00]	[0.00] *

Note: The lag selection for every variable is based on Akaike Info Criterion (AIC). Newey-West bandwidth selection with Bartlett kernel is used for the LLC test.
The Levin,Lin and Chu (LLC) and Im, Pesaran and Shin W-stat (IPS) tests have H_0: The series have a unit root.
LLC and IPS tests for all the series include a constant as an intercept.
*rejection of the null hypotheses of a unit root at the 1% significance level
**rejection of the null hypotheses of a unit root at the 5% significance level
***rejection of the null hypotheses of a unit root at the 10% significance level

4.2.4 Cointegration Tests

With the robust proof that every variable is non-stationary and become stationary at first difference, the panel cointegration tests have been applied to estimate the long-run equilibrium relationship among the variables for the equations 3.2, 3.3 and 3.5. The results of various co-integration tests for all the three equations suggested by Pedroni(1999) and Fisher (1932) are presented in Table 4.4, Table 4.5 and in Table 4.6.

It has been explained in the chapter three that cointegration will exist in a panel regression if majority of the tests of the Padroni (1999) reject the null hypothesis of the no co-integration. In the Table 4.4 five out of seven test statistics reject the null hypothesis of no cointegration. Therefore, alternate hypothesis is accepted that long run cointegrating equilibrium relationship does exist among the variables. Moreover, Fisher tests statistics also reject the null hypothesis of none, at most one and at most two co-integration vectors in the equation (3.2). Thus, alternate hypothesis of at least one, more than one and more than two co-integration vectors are accepted. Hence, there is robust proof that variables in the equation (3.2) have long-run equilibrium co-integrating relationship.

Table 4.4
Panel Cointegration test for the Equation (3.2)

Padroni Residual Cointegration Test				
Automatic lag length selection based on HQIC with a max lag of 4				
	Statistic	**Prob.**		
Panel v-Statistic	2.48153	0.0065*		
Panel rho-Statistic	-1.16522	0.122		
Panel PP-Statistic	-3.14869	0.0008*		
Panel ADF-Statistic	-3.24798	0.0006*		
Alternative hypothesis: individual AR coefficients. (between-dimension)				
Group rho-Statistic	0.714171	0.7624		
Group PP-Statistic	-1.74652	0.0404**		
Group ADF-Statistic	-2.48054	0.0066*		
Johansen Fisher Panel Cointegration Test				
Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)				
Hypothesized No. of CE(s)	**Trace test**	**Prob.**	**max-eigen test**	**Prob.**
None	102.5	0.00	66.88	0.000*
At most 1	50.18	0.00	31.93	0.0014*
At most 2	26.94	0.0079	25.35	0.0133**
At most 3	10.7	0.5549	10.75	0.5506
At most 4	11.76	0.4652	11.76	0.4652

Probabilities are computed using asymptotic Chi-square distribution.
*rejection of the null hypotheses at 1% significance level.
**rejection of the null hypotheses at 5% significance level.
***rejection of the null hypotheses at 10% significance level.

In Table 4.5 five out of seven test statistics reject the null hypothesis of no co-integration Therefore, alternate hypothesis is accepted that long run cointegrating equilibrium relationship does exist among the variables. Moreover, Fisher tests statistics also reject the null hypothesis of none, at most one, at most two and at most three co-integration vectors in the equation (3.3). The alternate hypothesis of at least one, more than one, more than two and more than three co-integration vectors are accepted. Hence, there is robust proof that variables in the equation (3.3) have long-run equilibrium co-integrating relationship.

Table 4.5
Panel Cointegration test for the Equation (3.3)

Pedroni Residual Cointegration Test		
Automatic lag length selection based on HQIC with a max lag of 4		
	Statistic	**Prob.**
Panel v-Statistic	1.768202	0.0385**
Panel rho-Statistic	-0.43876	0.3304
Panel PP-Statistic	-2.85488	0.0022*
Panel ADF-Statistic	-3.01195	0.0013*
Alternative hypothesis: individual AR coefficient. (between-dimension)		
	Statistic	**Prob.**
Group rho-Statistic	1.413785	0.9213
Group PP-Statistic	-1.54475	0.0612**
Group ADF-Statistic	-2.50281	0.0062*
Cross section specific results		

Johansen Fisher Panel Cointegration Test				
Hypothesized No. of CE(s)	**Trace test**	**Prob.**	**max-eigen test**	**Prob.**
None	233.5	0.00	156.6	0.00*
At most 1	103.1	0.00	43.67	0.00*
At most 2	67.7	0.00	44.71	0.00*
At most 3	33.35	0.0009	25.05	0.0146*
At most 4	17.92	0.1182	15.12	0.2348
At most 5	17.97	0.1167	17.97	0.1167

Probabilities are computed using asymptotic Chi-square distribution.
*rejection of the null hypotheses at 1% significance level.
**rejection of the null hypotheses at 5% significance level.
***rejection of the null hypotheses at 10% significance level

In Table 4.6 five out of seven test statistics reject the null hypothesis of no cointegration at 5 per cent level of significance. Therefore, alternate hypothesis is accepted that long run cointegrating equilibrium relationship does exist among the variables. Moreover, Fisher tests statistics also reject the null hypothesis of none, at most one, at most two and at most three co-integration vectors among the equation (3.3). Therefore, alternate hypothesis of at least one, more than one and more two and more than three co-integration vectors are accepted. Hence, there is strong proof that variables in the equation (3.3) have long-run equilibrium co-integrating relationship.

Table 4.6
Panel Cointegration test for the Equation (3.5)

Pedroni Residual Cointegration Test		
Automatic lag length selection based on HQIC with a max lag of 4		
	Statistic	**Prob.**
Panel v-Statistic	1.03593	0.1501
Panel rho-Statistic	-0.44694	0.3275
Panel PP-Statistic	-2.80485	0.0025*
Panel ADF-Statistic	-3.01019	0.0013*
Alternative hypothesis: individual AR coefficients. (between-dimension)		
	Statistic	**Prob.**
Group rho-Statistic	1.203595	0.88
Group PP-Statistic	-1.79868	0.03**
Group ADF-Statistic	-2.86033	0.002*

Johansen Fisher Panel Cointegration Test				
Hypothesized No. of CE(s)	**Trace test**	**Prob.**	**max-eigen test**	**Prob.**
None	205	0.00	123.4	0.00*
At most 1	109.2	0.00	70.67	0.00*
At most 2	53.49	0.00	30.1	0.002*
At most 3	31.38	0.0017	26.48	0.009*
At most 4	14.88	0.2483	14.44	0.2734
At most 5	15.45	0.2177	15.45	0.2177

Probabilities are computed using asymptotic Chi-square distribution.
*rejection of the null hypotheses at 1% significance level.
**rejection of the null hypotheses at 5% significance level.
***rejection of the null hypotheses at 10% significance level

4.2.5 The FMOLS Long Run Estimates

After finding the long run cointegrating relation among the variables, the FMOLS has been applied to estimate the long-run parameters. The results for all models are shown in Table-4.7. The main objective of this analysis was to investigate the presence of the PHH effect in the ASEAN countries. In addition, the analysis also intends to investigate the role of the export of pollution-intensive goods in shaping the EKC in these countries. From the results of FMOLS, it is evident that the coefficient on income (X) is positive and statistically significant and coefficient on squared income (X^2) is negatively significant. These significant coefficients prove the existence of the EKC for the ASEAN region. These results are in line with (Borhan et al., 2012; Kumar & Khanna, 2009); Lipford and Yandle (2010); (Saboori et al., 2012a).

The peak turning point of the EKC where pollution starts to decline with further economic growth is observed at $17921 GDP per capita in the equation (3.2). All the ASEAN countries are well below to this per capita income level except Singapore and Malaysia. Singapore is the only country whose per capita income is for above then the turning point income of the EKC. These are expected results as Singapore is a developed country as compared to the other countries in the region. These results are in line with Jain and Chaudhuri (2009) who claims that advanced countries are on the falling part of the EKC while developing countries are on the rising part of the EKC.

Table 4.7
Estimation Results of Pooled FMOLS
Dependant Variables pollution (CO_2)

Variables	**Model No 3.2**	**Model No 3.3**	**Model No 3.5**
X	0.014337 (0.01) **	0.009638 (0.02) **	0.019725 (0.00) *
X^2	-4.00E-07 (0.00) *	-3.30E-07 (0.00) *	-6.76E-07 (0.00) *
XDJA*X			2.24E-09 (0.00) *
XDJA		1.71E-05 (0.00) *	
FDI	9.91E-01 (0.00) *	8.06E-01 (0.00) *	7.99E-01 (0.00) *
EC	0.019565 (0.10) **	0.020881 (0.09) **	0.00974 (0.10) **
R^2	0.836	0.868	0.872
Adjusted R^2	0.825	0.858	0.863
Observations	150	150	150
Turning Point	17921	14603	17454^

^The peak turning point of the EKC at average per capita income of the ASEAN countries in sample period.

* 1% significance level.
** 5% significance level.
***10% significance level.

These results imply that more economic growth in the ASEAN countries especially in Indonesia, Thai-land, Philippine and Vietnam that are well below to the peak turning point of the EKC, will bring more emission of CO_2. These countries therefore, need to pursue effective environment policies while pursuing the economic growth.

In the equation (3.2) the exports of pollution-intensive goods are assumed to exist implicitly that connotes they would affect the income level and thereby delays the turning point of the EKC than it would have been without the export of these goods. There may be some ambiguities regarding the implicit effect of the export of pollution-intensive goods when it has not been included explicitly. The high per capita income level at the turning point of the EKC may or may not be due to the production and export of the pollution-intensive goods to Japan. There may be some other factors responsible for this outcome.

In order to address these scepticisms, the equation (3.3) has been devised that includes export of pollution intensive-goods to Japan as another explanatory variable. The results of the equation (3.3) are almost like the results of the first model in terms of magnitude, sign and significance level of the coefficients. As so for the impact of export of pollution-intensive is concerned, it has positive and significant impact on pollution. In other words, the increase in the export of pollution-intensive goods to advanced countries like Japan would lead to increase in pollution in the ASEAN countries. Interestingly, when the exports of pollution-intensive goods are controlled to affect the income, the peak turning point of the EKC has been observed at early per capita GDP of $14603 in the equation (3.3). Therefore, it can be concluded that when income is exclusive of the exports of pollution-intensive goods, the per capita income level where pollution starts to decline with further increase in income, arrives earlier. In other words, the specialization and export of pollution intensive-goods delaying the turning point of the EKC, thereby increasing the environmental cost of economic growth for the ASEAN countries.

The Equation (3.3) is superior over the equation (3.2) in terms of specification as it has greater explanatory power than the equation (3.2) as evinced by higher Adjusted R^2 (coefficient of termination) of the equation (3.3) as compared to of the equation (3.2).

The exports of pollution-intensive goods are assumed to affect the peak turning point of the EKC owing to its impact on income, whereas exports of pollution-intensive goods may also affect the pollution directly. This issue may raise the scepticism about the interpretation of the findings of the equation (3.2) and the equation (3.3). To overcome these shortcomings, the equation (3.5) has been devised after the few modifications made in the equation (3.3). Unlike the equation (3.3), the exports of pollution-intensive goods are taken as an interaction term with income in the equation (3.5). The results of this new model are almost tantamount to the equation (3.2) and, the equation (3.3) in terms of magnitude, sign and significance level of the coefficients.

The exports of pollution-intensive goods taken as an interaction term have significant positive impact on pollution. These results indicate that at any given level of income pollution in the ASEAN countries will increase with the increase in the exports of pollution-intensive goods. This also can be interpreted in other way around. To trace the true impact of the exports of pollution-intensive goods, this specification is very important. It is because this model enables us to locate the turning point of the EKC both inclusive and exclusive of the exports of pollution-intensive goods.

The turning point income level of the EKC for the equation (3.5) is calculated by the formula given in the equation (3.6). In this formula, if Export of Pollution-intensive Goods from ASEAN to Japan (XDJA) are taken as zero, turning point per capita GDP value turns to be

\$14590. However, considering the average value of XDJA in above mentioned formula the turning point per capita GDP value reaches to \$17454. Hence specialization and exports of the ASEAN countries in pollution-intensive goods (chemical, plastic, paper and pulp, woods) to advanced countries like Japan does lead to delaying of the turning point of the EKC by \$ 2864.

It is also worth mentioning that peak turning point per capita GDP in the equation (3.5) at average exports of pollution-intensive goods is almost like the turning point per capita income in the equation (3.2) where impact of export of pollution-intensive is assumed to exist implicitly. This indicate that three models adequately explain the effect of pollution-intensive exports on pollution in the ASEAN countries. Furthermore, the coefficients of explanatory variables as well as of the interaction terms are consistent in term of sign, magnitude and significance level. The equation (3.5) has the highest Adjusted R^2 than the equation (3.2) and (3.3). It implies that equation (3.5) is more correctly specified. The results of the study confirm both the contributing role of the pollution-intensive exports to pollution and delaying of the EKC turning point and thereby enhancing environment cost of economic growth.

The coefficient on FDI in all three models are positive and significant. It implies that FDI also has caused the CO_2 emission to rise in the ASEAN countries. This empirical output is another support to the PHH stance about the relationship between FDI and pollution in developing countries. These results are in line with the research studies such as Baek and Koo (2009); (Kostakis et al., 2017; Neequaye & Oladi, 2015; Ren et al., 2014) who claim that FDI has increased the pollution in developing countries apart from increasing the income and employment.

Moreover, the coefficients on energy consumption (EC) in all three models are also positively significant. This implies that EC also has contributed to the increase in the emission of GHG from ASEAN region. These results are in line with the findings of previous research studies such as (Ang, 2007a; Halicioglu, 2009a; Ramanathan, 2002).

4.2.6 The Results of Wald Test of Coefficient Restriction

The Wald test of coefficient restriction has been applied to examine whether the interaction term in equation (3.5) should be included or not. The results of the test are shown in Table 4.8. The t-statistics, F-statistic and Chi-square statistics reject the null hypothesis (H_0) at five percent significance that interaction term does not matter in the equation (3.5). The alternate hypothesis (H_1) therefore, is accepted that interaction term does matter in said equation. Hence, Wald test of coefficient restriction also support the inclusion of the interaction term in the EKC model to trace the true impact of exports of pollution-intensive goods on the turning point GDP per capita.

Table 4.8
Wald Test of Restrictions

Null Hypothesis: C (3) =0	Interaction does not matter in the model		
Alternate Hypothesis: C (3) =0	Interaction does matter in the model		
Test Statistic	Value	Df	Probability
t-statistic	3.731029	139	0.0003**
F-statistic	13.92057	(1, 139)	0.0003**
Chi-square	13.92057	1	0.0002**
F Normalized Restriction (= 0)		Value	Std. Err.
C(3)		2.24E-09	5.99E-10
Restrictions are linear in coefficients.			

*rejection of the null hypotheses at 1% significance level.
**rejection of the null hypotheses at 5% significance level.
***rejection of the null hypotheses at 10% significance level

In short following conclusions can be drawn from this part of the analysis.

- The EKC does exist for a pool of six ASEAN countries namely Singapore, Malaysia, Indonesia, Thailand, Philippine and Vietnam for the emission of GHG for the period 1989-2014.
- The peak turning point of the EKC is observed at $17921 per capita GDP. Singapore is the only country that has crossed this threshold. The other five ASEAN countries except Malaysia are well below to this per capita GDP. Therefore, it can be stated that economic growth without any policy measure for pollution control will be accompanied by more emission of GHG in the ASEAN region.
- When the effect of exports of pollution-intensive goods is controlled in the equation (3.3) the turning point of the EKC arrives earlier at $14603 per capita GDP. Therefore, it can be concluded that production and exports of pollution-intensive goods (chemical, plastic, paper and pulps and wood) have delayed the turning point of the EKC and have increased the environmental cost of economic growth for the ASEAN countries.
- The results of the equation (3.5) also support the above-mentioned results about the EKC and the PHH. The peak turning point of the EKC turns to be $14590 when the ASEAN countries do not export pollution-intensive goods to Japan. However, considering the average value of XDJA, the turning point per capita GDP value reaches to $17454.
- The positive significant coefficients on FDI in all three equations indicate that FDI also has contributed to the increase in GHG emissions in the ASEAN countries.

4.3 Results and Discussions of the Second Analysis

The second analysis also utilizes the FMOLS to estimate the long run relationship among the variables. This section aims to investigate the presence of the PHH in the ASEAN countries in the context of the EKC framework. Moreover, it also assesses the extent to which the exports of pollution-intensive goods from the ASEAN to the USA contribute to determine the slope of the EKC in the ASEAN countries.

4.3.1 Descriptive statistics

Descriptive statistics describe basic features of the data whether it is cross-sectional, time series or panel. Moreover, they also describe the degree of the variation of the variables. Descriptive statistics are grouped into two categories: (i) measures of central tendencies (mean, median and mode); (ii) measures of dispersion (standard deviation (S.D), minimum and maximum values variables, kurtosis and skewness). Table 4.1 reveals the descriptive statistics of the variables that have been chosen in the model for the analysis of the EKC and the PHH. The maximum CO_2 emission is observed at 641 $MtCO_2$ in Indonesia in 2014 while minimum CO_2 emission is observed 13.47 $MtCO_2$ in Singapore in 2010. The mean value of 147 $MtCO_2$ with 125 $MtCO_2$ standard deviation indicates large amount of the variation in CO_2 emission in the region.

Similarly, GDP per capita (X) also displays substantial variation. Maximum GDP per capita is noted at 56010$ of Singapore in 2014 while, minimum GDP per capita was 97.2$ of Vietnam in 1989. Moreover, significant variation is also observed in the exports of pollution-intensive goods (XDUSA) from ASEAN to USA and in energy consumption (EC) as evinced by their large values of S.D with respect to mean values. However, FDI inflows have been consistent as compared to other variables. Difference between large and small values of the FDI is not as large as of the other variables. It indicates that the ASEAN countries have consistently received the FDI inflows in the sample period.

Table 4.9
Descriptive Statistics

Variables	CO_2	X	EC	FDI	XDUSA
Mean	147	7125	1697	7.58E+09	1570301
Median	104	2356	845	3.84E+09	1166951
Maximum	641	56010	7370	6.85E+10	8727829
Minimum	13.47	97.2	269	4.55E+09	123450
Std. Dev.	125	11852	1679	1.18E+10	1746569
Skewness	1.59	2.57	1.42	3.246102	1.912153
Kurtosis	5.93	9.26	3.90	14.54442	6.946982
Jarque-Bera	122	427	58.1	1140.246	196.3258
Observations	156.	156	156	156	156

4.3.2 Correlation Analysis

Correlation analysis highlights how much variables are related to each other. This information is useful to avoid the problem of multicollinearity in regression equation. Table 4.10 details the correlation among the proposed variables. According to the results, the explanatory variables income, EC, FDI and XDUSA are not are not as highly correlated to each other that can disturb the BLUE[22] properties of the regression models.

Table 4.10
Correlation Matrix

Variables	CO_2	X	EC	FDI	XDUSA
CO_2	1.00	-0.29	0.34	0.26	0.234
X	-0.29	1.00	0.85	0.76	-0.29
EC	0.34	0.85	1.00	0.85	0.25
FDI	0.26	0.76	0.85	1.00	0.26
XDUSA	0.34	-0.29	0.25	0.26	1.00

[22] BLUE properties imply that coefficients of the model are best, linear, unbiased and efficient

4.3.2 Panel Unit Root Tests

It is the precondition of the panel regression that variables must be stationary. For this purpose, the panel unite root tests LLC (2002) and IPS (2003) have been applied. The panel cointegration estimation technique FMOLS requires that time series variables in the panel must be integrated of the same order. The results of the LLC and IPS unit root tests for all-time series CO_2, X, X^2, EC, FDI and XDUSA have been summarized in Table 4.11. The results indicate that LLC and IPS statistics do not reject the null hypothesis that all the variables in the panel are non-stationary however, at first difference, all the variables become stationary. Therefore, it can be concluded that all the variables in the panel are integrated of order I (1).

Table 4.11
Results of Panel Unit Root Tests

	LLC		IPS	
Variable	**Level**	**First Difference**	**Level**	**First Difference**
CO_2	2.09	-10.36	4.05	-9.26
	[1.00]	[0.00] *	[1.00]	[0.00] *
X	7.13	-5.54	8.07	-4.1
	[1.00]	[0.00] *	[1.00]	[0.02] **
X2	6.69	-1.97	6.67	-1.27
	[1.00]	[0.02] **	[1.00]	[0.10] ***
FDI	3.72	-9.59	4.43	-12.19
	[0.99]	[0.00] *	[0.99]	[0.00] *
EC	0.52	-8.47	0.51	-7.84
	[0.70]	[0.00] *	[0.70]	[0.00] *
XDUSA	3.31	-7.28	4.31	-7.34
	[1.00]	[0.002] *	[1.00]	[0.00] *

Note: The lag selection for every variable is based on Akaike Info Criterion (AIC). Newey-West bandwidth selection with Bartlett kernel is used for the LLC test.
The Levin, Lin and Chu (LLC) and Im, Pesaran and Shin W-stat (IPS) tests have H_0: The series has a unit root. LLC and IPS tests for all the series include a constant as an intercept.
*rejection of the null hypotheses of a unit root at the 1% significance level
**rejection of the null hypotheses of a unit root at the 5% significance level
***rejection of the null hypotheses of a unit root at the 10% significance level

4.3.3 Panel Cointegration Test

After investigating the unit root problem, the panel cointegration tests have been applied to examine the long-run equilibrium relationship among the variables. The test statistics of co-integration tests Pedroni (1999b) and Fisher (1932) for the equations (3.2),(3.7) and (3.8) are reported in Table 4.12, Table 4.13 and in Table 4.14. It has been explained in chapter three that cointegration exists in a panel regression if majority of the tests of the Padroni (1999) reject the null hypothesis of the no co-integration among the variables.

In Table 4.12 five out of seven test statistics reject the null hypothesis of no cointegration. Therefore, the alternate hypothesis is accepted that long run cointegrating equilibrium relationship does exist among the variables. Moreover, Fisher tests statistics also reject the null hypothesis of none, at most one and at most two co-integration vectors in the equation (3.2). Therefore, alternate hypothesis of at least one, more than one and more than two co-integration vectors are accepted. Hence, cointegration tests provide robust proof that the variables in the equation (3.2) have long-run equilibrium co-integrating relationship.

Table 4.12
Panel Cointegration test for the Equation (3.2)

Pedroni Residual Cointegration Test				
Automatic lag length selection based on HQIC with a max lag of 4				
	Statistic	**Prob.**		
Panel v-Statistic	2.48153	0.006*		
Panel rho-Statistic	-1.16522	0.122		
Panel PP-Statistic	-3.14869	0.001*		
Panel ADF-Statistic	-3.24798	0.001*		
Group rho-Statistic	0.714171	0.7624		
Group PP-Statistic	-1.74652	0.0404*		
Group ADF-Statistic	-2.48054	0.0066*		
Johansen Fisher Panel Cointegration Test				
Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)				
Hypothesized No. of CE(s)	**(Trace test)**	**Prob.**	**(max-eigen test)**	**Prob.**
None	102.5	0.00	66.88	0.000*

Table 4.12 continued

At most 1	50.18	0.00	31.93	0.001*
At most 2	26.94	0.0079	25.35	0.013*
At most 3	10.7	0.5549	10.75	0.5506
At most 4	11.76	0.4652	11.76	0.4652

Probabilities are computed using asymptotic Chi-square distribution.
*rejection of the null hypotheses at 1% significance level.
**rejection of the null hypotheses at 5% significance level.
***rejection of the null hypotheses at 10% significance level.

In Table 4.13 five out of seven test statistics reject the null hypothesis of no co-integration Therefore, alternate hypothesis is accepted that long run cointegrating equilibrium relationship does exist among the variables. Moreover, Fisher tests statistics also reject the null hypothesis of none, at most one, at most two and at most three co-integration vectors in the equation (3.7). The alternate hypothesis of at least one, more than one, more than two and more than three co-integration vectors are accepted. Hence, there is robust proof that variables in the equation (3.7) have long-run equilibrium co-integrating relationship.

Table 4.13
Panel Cointegration test for the Equation (3.7)

Pedroni Residual Cointegration Test

Automatic lag length selection based on HQIC with a max lag of 4

	Statistic	**Prob.**
Panel v-Statistic	1.768202	0.039*
Panel rho-Statistic	-0.43876	0.330
Panel PP-Statistic	-2.85488	0.002*
Panel ADF-Statistic	-3.01195	0.001*
	Statistic	**Prob.**
Group rho-Statistic	1.413785	0.921
Group PP-Statistic	-1.54475	0.061***
Group ADF-Statistic	-2.50281	0.006*
Cross section specific results		

Johansen Fisher Panel Cointegration Test

Hypothesized No. of CE(s)	**Fisher Stat.* (from trace test)**	**Prob.**	**Fisher Stat.* (from max-eigen test)**	**Prob.**
None	233.5	0.00	156.6	0.00*

Table 4.13 continued

At most 1	103.1	0.00	43.67	0.00*
At most 2	67.7	0.00	44.71	0.00*
At most 3	33.35	0.001	25.05	0.015**
At most 4	17.92	0.118	15.12	0.2348
At most 5	15.45	0.2177	15.45	0.2177

Probabilities are computed using asymptotic Chi-square distribution.
*rejection of the null hypotheses at 1% significance level.
**rejection of the null hypotheses at 5% significance level.
***rejection of the null hypotheses at 10% significance level.

In Table 4.14 four out of seven test statistics reject the null hypothesis of no cointegration at 5 per cent level of significance. Therefore, alternate hypothesis is accepted that long run cointegrating equilibrium relationship does exist among the variables. Moreover, Fisher tests statistics also reject the null hypothesis of none, at most one, at most two and at most three co-integration vectors among the equation (3.8). Therefore, alternate hypothesis of at least one, more than one and more two and more than three co-integration vectors are accepted. Hence, there is ample evidence to support that variables in the equation (3.8) have long-run equilibrium co-integrating relationship.

Table 4.14
Panel Cointegration test for the Equation (3.8)

Pedroni Residual Cointegration Test

Automatic lag length selection based on HQIC with a max lag of 4

	Statistic	**Prob.**
Panel v-Statistic	1.03593	0.1501
Panel rho-Statistic	-0.44694	0.3275
Panel PP-Statistic	-2.80485	0.003*
Panel ADF-Statistic	-3.01019	0.001*
	Statistic	**Prob.**
Group rho-Statistic	1.203595	0.88
Group PP-Statistic	-1.79868	0.03**
Group ADF-Statistic	-2.86033	0.002*

Johansen Fisher Panel Cointegration Test

Hypothesized No. of CE(s)	**Fisher Stat.* (from trace test)**	**Prob.**	**Fisher Stat.* (from max-eigen test)**	**Prob.**
None	205	0.00	123.4	0.00*

Table 4.14 continued

At most 1	109.2	0.00	70.67	0.00*
At most 2	53.49	0.00	30.1	0.003*
At most 3	31.38	0.0017	26.48	0.009*
At most 4	14.88	0.2483	14.44	0.2734
At most 5	15.45	0.2177	15.45	0.2177

Probabilities are computed using asymptotic Chi-square distribution.
*rejection of the null hypotheses at 1% significance level.
**rejection of the null hypotheses at 5% significance level.
***rejection of the null hypotheses at 10% significance level.

4.3.4 The FMOLS Long Run Estimates

After proving the long run cointegrating relation among the variables, the FMOLS has been used to estimate the coefficient of the independent variables. The results are reported in Table 4.14. According to the results, the coefficient on GDP per capita (X) is positive and statistically significant at one percent significant level and the coefficient on squared of the GDP (X^2) is negatively significant at one percent significant level. This proves the existence of the EKC relationship between economic growth and pollution in the ASEAN countries.

The turning point of the EKC where pollution starts to decrease with further increase in economic growth is found at $17921 per capita in the equation (3.2). The ASEAN countries are well below to this per capita income level except Singapore and Malaysia. Singapore is the only country among the ASEAN whose per capita income is well above then the turning the point income of the EKC. Therefore, it can be stated that economic growth without any environment policy would be accompanied by more pollution in the ASEAN countries.

Table 4.15
Estimation Results of Pooled FMOLS
Dependant Variables pollution (CO_2)

Variables	Model No (3.2)	Model No (3.7)	Model No (3.8)
X	0.014337	0.008447	0.012813
	(0.01) **	(0.01) **	(0.02) **
X^2	-4.00E-07	-3.30E-07	-2.61E-07
	(0.00) *	(0.00) *	(0.00) *
XDUSA*X			1.04E-09
			(0.00) *

Table 4.15 continued

XDUSA		2.03E-05	
		(0.00) *	
FDI	9.91E-01	7.76E-09	1.16E-01
	(0.00) *	(0.00) *	(0.00) *
EC	0.019565	0.021666	0.0259
	(.10) ***	(o.10) ***	(0.09) ***
R^2	0.836	0.841	0.850
Adjusted R^2	0.825	.829	0.839
Observations	150	150	150
Turning Point	\$17921	\$13198	\$27674^

^The peak turning point of the EKC at average per capita income of the ASEAN countries in sample period.

* 1% significance level.
** 5% significance level.
***10% significance level.

These results are in line with the findings of the Jain and Chaudhuri (2009) who claimed that advanced countries are on the upward slope of the EKC while developing countries are on the downward slope of the EKC. In the equation (3.2) the exports of pollution-intensive goods from the ASEAN to the USA are assumed to exist implicitly. It implies that exports of pollution-intensive goods would affect the income level and would delay the turning point of the EKC than it would have been without the export of the dirty goods. To find the turning point of the EKC that is exclusive of the impact of the export of pollution-intensive goods to the USA, the equation (3.7) has been devised. In the Equation (3.7) the export of pollution-intensive goods to the USA from the ASEAN countries has been taken as control variable. The results from the (3.7) are almost like results of the equation (3.2) in terms of the sign, significance and magnitude of the coefficients.

The coefficient of export of pollution-intensive is positive and significant at one percent significant level. It implies that the increase in the export of pollution-intensive goods to advanced countries like the USA would lead to increase in pollution in the ASEAN countries. The peak turning point is observed earlier at \$13198 in the equation (3.7) where the impact export of pollution-intensive goods on pollution is controlled. Therefore, it can be stated that specialization and exports of pollution-intensive goods to the USA have delayed the turning point of the EKC. These results imply that specialization patterns have increased the environment cost of economic growth in the ASEAN region.

The exports of pollution-intensive goods are assumed to affect the peak turning point of the EKC owing to its impact on income, whereas export of pollution-intensive goods may also affect the pollution directly. This issue may raise the scepticism about the interpretation of the findings of the equation (3.2) and the equation (3.7). To overcome these shortcomings, the equation (3.8) has been developed by modifying the equation (3.7) wher exports of pollution-intensive goods to the USA have been taken as an interaction term with income.

The results of the equation (3.8) are also like the equation (3.7) and (3.2) in terms of magnitude, sign and significance. Adjusted R^2 statistics also support that equation (3.8) is more correctly specified than the equation (3.7) and (3.2). The interaction term has significant positive effect on pollution. It implies that at any given level of income pollution in the ASEAN countries will increase with an increase in the exports of pollution-intensive goods.

The peak turning point income level of the EKC for the equation (3.8) is calculated by the formula given in the equation (3.6). In this formula, if XDUSA is taken as zero, the turning point per capita GDP value turns to be $24545. However, taking the average value of XDUSA in above-mentioned formula the turning point per capita GDP value reaches to $27674. These results indicate that specialization and export of pollution-intensive goods (chemical, plastic, paper and pulp, woods) to advanced countries like the USA delaying the turning point of EKC. The results of the study confirm both the contributing role of the pollution-intensive export to pollution and delaying of the EKC turning point thereby enhancing environment cost of economic growth in the ASEAN countries.

The coefficient on FDI in all three models are positive and significant at one percent significant level. It implies that FDI also has caused the CO_2 emissions to rise in the ASEAN countries. This result is another support to the PHH stance about the role of the FDI in developing countries. These results are in line with Baek and Koo (2009); (Kostakis et al., 2017; Neequaye & Oladi, 2015; Ren et al., 2014) that claim a positive impact of the FDI on the pollution in developing countries.

Moreover, the coefficients on energy consumption (EC) in all three models are also positive significant at ten percent significant level. This implies that EC also has contributed to the increase in the CO_2 emissions. These results are in line with the findings of (Ang, 2007a; Halicioglu, 2009a; Ramanathan, 2002).

4.2.5 The Results of Wald test of Coefficient Restriction

The Wald test of coefficient restriction has been applied to examine whether the interaction term in the equation (3.8) should be included or not. The t-statistics, F-statistic and Chi-square statistics rejects the null hypothesis (H_0) at five percent significance level that interaction term should not be included in the equation (3.8). Therefore, the alternative hypothesis (H_1) accepted interaction term should be included in the equation (3.8). The results of the Wald test are reported in the following Table.

Table 4.16
Wald Test of Restrictions

Null Hypothesis: C (3) =0	Interaction does not matter in the model		
Alternate Hypothesis: C (3) =0	Interaction does matter in the model		
Test Statistic	Value	Df	Probability
t-statistic	3.68648	139	0.0003**
F-statistic	13.59016	(1, 139)	0.0003**
Chi-square	13.59016	1	0.0002**
Normalized Restriction (= 0)		Value	Std. Err.
C (3)		1.04E-09	2.83E-10
Restrictions are linear in coefficients.			

**rejection of the null hypotheses at 5% significance level

The following results can be summarized from this part of the analysis.

- The EKC does exist for a pool of six ASEAN countries namely Singapore, Malaysia, Indonesia, Thailand, Philippine and Vietnam for the emission of CO_2 for the period 1989-2014.
- The peak turning point of the EKC is observed at \$17921 per capita. Singapore is the only country that has crossed this threshold. The other five ASEAN countries except Malaysia are well below to this per capita income level. Therefore, it can be stated that economic growth without any policy measure to control pollution will be accompanied by more emission of GHG in the ASEAN region.
- When the effect of exports of pollution-intensive goods to the USA is controlled in the equation (3.7) the turning point of the EKC arrives earlier at \$13198 per capita. Therefore, it can be concluded that production and export of pollution-intensive goods to the USA (chemical, plastic, paper and pulps and wood) have delayed the turning point of the EKC thereby, have increased the environmental cost of economic growth for the ASEAN countries.
- The results of equation (3.8) also support the above-mentioned results about the EKC and the PHH. The peak turning point of the EKC turns to be \$24545 when the ASEAN countries do not export pollution-intensive goods to the USA. However, considering the average value of XDUSA in above-mentioned formula the turning point per capita income GDP value reaches to \$27674.
- The positive significant coefficient on FDI in all three equations indicates that FDI is also contributing to the increase in CO_2 emissions in the ASEAN countries

4.4 Conclusion of the Chapter

This chapter empirically examines the PHH in the frame work of the EKC for ASEAN countries in two sections. The impact of export of pollution-intensive goods from the ASEAN to Japan on pollution and on the slope of EKC in the ASEAN has been appraised in Section 4.2. While section 4.3 explains impact of pollution-intensive goods from the ASEAN to the USA on pollution and on the slope of EKC in the ASEAN countries. The policy recommendations of the empirical results have been detailed in the next chapter.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter has six sections. Section 5.2 recaps the study including objectives, data, methodology and findings. Section 5.3 provides the recommendations for policy implications based on the empirical results of the study. Section 5.4 explains the limitations of the current research while, Section 5.5 suggests the areas for further research that have been identified during the research process. Finally, Section 5.6 concludes the chapter.

5.2 Recap of the Study

The aim of the study is to examine the existence of the Pollution Haven Hypothesis (PHH) trade patterns for the Association of the South East Asian Nations (ASEAN) countries in the context of the Environmental Kuznets Curve (EKC) framework. For this purpose, the exports of four pollution-intensive industries (chemical, paper and pulps, plastic and woods) from the ASEAN to advanced countries have been selected for the analysis. These industries are assumed to have the most pollution-intensive production process. As the USA and Japan are the major trade partner of the ASEAN countries therefore, export of pollution-intensive goods from the ASEAN to these nations have been chosen for the analysis. Due to the non-availability of the data the, the analysis has been confined to 1989 -2015 time-period and to six major ASEAN countries namely Singapore, Malaysia, Indonesia, Thai-Land Philippine and Vietnam.

Carbon dioxide (CO2) emission has been taken as a measure of pollution as it is considered authentic environment data. Moreover, CO_2 is also considered a major Green House Gas (GHH) and is strongly correlated with local pollutants like sulphur dioxide (SO_2), ground-level ozone, and carbon monoxide (CO). Fluctuations in CO_2 emission therefore, can be taken as increase and decrease of the pollution. The studies like (Hassaballa, 2013; Kivyiro & Arminen, 2014) provide various justifications for the use of CO_2 emission as a measure of pollution. Following the literature about the PHH, the Foreign direct investment (FDI) and energy consumption have been taken as control variables.

The 26 years data for six countries have been analysed in panel settings. The panel unite root tests provided a strong proof that time series data chosen for the analysis is not stationary. It is the violation of one of the important assumption of the regression analysis. The traditional panel estimation methods therefore, cannot be used to estimate the relationship among the variables. However, following the recent literature on econometrics, panel cointegration process including panel cointegration tests and panel cointegration estimation methods can be employed to estimate the relationship among the non-stationary variables. Current study utilizes (Pedroni, 1999, 2004) and Fisher (1932) panel co-integration tests to investigate the co-integration relation among the variables and Fully Modified Least Square (FMOLS) by Pedroni (2001) to estimate the long run relationship.

The empirical results are categorized into two sections. The section 4.2 details the analysis of the impact of the export of pollution-intensive goods from the ASEAN to Japan(XDJA). While the section 4.3 explains the impact of export of pollution-intensive goods from the ASEAN to the USA(XDUSA).

According to the results of section 4.2, the EKC does exist in a pool of the six ASEAN countries namely Singapore, Malaysia, Indonesia, Thailand, Philippine and Vietnam. The peak turning point of the EKC is observed at $17921 per capita. Singapore is the only country that has crossed this threshold. The other five ASEAN countries except Malaysia are well below to this per capita income level. Therefore, it can be stated that economic growth without any environmental policy measures will be accompanied by more emissions of CO_2 in the ASEAN region.

Moreover, when the effect of XDJA is controlled the turning point of the EKC arrives earlier at \$14603 per capita. It can be concluded that production and export of pollution-intensive goods (chemical, plastic, paper and pulps and wood) have delayed the turning point of the EKC. In other words, exports of pollution-intensive industries have increased the environmental cost of economic growth. In addition, the positive significant coefficient on FDI in all three equations indicate that FDI is also has contributed to the increase in CO_2 emission from the ASEAN countries.

The results of the section 4.3 also indicate that the EKC does exist for the ASEAN countries. When the effect of XDUSA is controlled the turning point of the EKC arrives earlier at \$13198 per capita. Therefore, it can also be concluded that production and export of pollution-intensive goods from the ASEAN to the USA have delayed the turning point of the EKC thereby, have increased the environmental cost of economic growth for the ASEAN countries. Moreover, the positive significant coefficient on FDI in all the equations indicate that FDI also has contributed to the increase in CO_2 emissions in the ASEAN countries.

There may be some scepticism about the implicit impact of the export of pollution-intensive exports on peak turning point of the EKC. The difference in peak turning point income level of the EKC for the equations 3.2 and 3.3 may be due to other factors then export of pollution-intensive goods. This issue may raise the scepticism about the interpretation of the findings from equation (3.3). To overcome these shortcomings, the XDJA is taken interactively with income in equation (3.5). The results of this new equation are almost tantamount to the equations (3.2) and (3.5) in terms of magnitude, sign and significance of the coefficients.

The exports of pollution-intensive goods taken as an interaction term have significant positive effect on pollution. These results indicate that at any given level of income, pollution in the ASEAN countries will increase with increase in the exports of pollution-intensive goods. This also can be interpreted in other way round. A decrease in the export of polltion-intensive goods will result in a decrease in pollution and earlier EKC turning point. To trace the true impact of the exports of pollution-intensive goods, this specification enables to locate the turning point of the EKC both inclusive and exclusive of the exports of pollution-intensive goods.

When (XDJA) are taken zero the turning point per capita GDP value turns to be \$14590 in equation (3.5). However, considering the average value of XDJA the turning point per capita GDP value reaches \$17454. Hence specialization and export of the ASEAN countries in pollution-intensive goods (chemical, plastic, paper and pulp, woods) to advanced countries like Japan delays the turning point in EKC by \$ 2864.

It is also worth mentioning that peak tuning point per capita GDP in equation (3.5) at average exports of pollution-intensive goods is almost like the turning point per capita income in equation (3.2) where impact of exports of pollution-intensive is assumed to exist implicitly. This indicate that three equations adequately explain the effect of pollution-intensive exports on pollution in the ASEAN countries. Furthermore, the coefficients of explanatory variables as well as of the interaction term are consistent in term of sign, magnitude and significance level. The results of the study confirm both the contributing role of the pollution-intensive export to pollution and delaying of the EKC turning point thereby enhancing environment cost of economic growth for ASEAN countries. The negative significant coefficients on FDI in all three equations indicate a contributing role of the FDI to the increase the CO_2 emissions from the ASEAN countries.

The results from Section 4.3 are also like the results from Section 4.2. It implies that XDUSA has similar impact on CO_2 emissions and on the slope of the EKC as of the XDJA.

5.3 Policy Recommendations

In recent times, the environmental issues like air and water pollution, environmental changes and global warming have attracted significant attention of communities, academic scholars and of policymakers. Environmental issues exert serious threats on humane life as well as future of this planet. The attempts are underway to understand the driving factors of environmental changes. The theories like EKC and the PHH have tried to explain this phenomenon in economic prospectus. However, the existing environment policies that are based on reducing the emissions of greenhouse gases domestically, overlook the importance of embodied CO_2 emission in internationally traded flows. The effects of trade liberalization on environment quality of a country depends on differences in factor endowments as well as differences in environmental policies across the countries.

The underlying study investigates environmental issues of the ASEAN countries in the context of PHH theory in the EKC framework. According to the conclusions drawn from the results of the study, the PHH holds in case of the ASEAN trade with advanced countries. Moreover, the results also confirm that economic growth does maintain an inverted U-shaped EKC relationship between income and pollution. Based on the results of the current study, the followings recommendations can be made.

Except Singapore, the per capita income of the ASEAN countries is not high enough to turn the EKC in near future therefore, CO_2 emission will increase with the increase in income in these countries. The pollution will not be reduced by itself unless economic growth is not accompanied by active environment policies. However, current study does not recommend stopping the economic growth rather it recommends growing differently. The investment and trade liberalization policies often result in environmental degradation owing to suboptimal environment policies however, it does not follow that trade and investment should be restricted. The optimal solution lies in more efficient and more cautious trade and environment policies.

If the demand for pollution-intensive products does not fall with the rising income in advanced countries, then a decline in the share of industrial activities in GDP simply reflects that this demand is being met by the imports from developing countries. It implies that advanced countries have displaced pollution-intensive industries and have become the importers of these pollution-intensive products. A logical question arises, to whom present developing countries would pass their pollution-intensive production process in future when these developing countries would become rich?

Hence, current study does not recommend any partial solution for the environmental problems of the world especially for global warming that are mainly driven by the emissions of the CO2. The necessary message of the PHH is that world pollution cannot be curtailed unless advanced countries reduce their high mass consumption. It is necessary for the existence of the world EKC that income elasticity of demand for manufacturing products particularly of the pollution-intensive products, should fall as income increases.

Moreover, the difference in environmental policies among countries have increased the displacement of the pollution-intensive industries from developed to developing countries. The production and export of these industries from developing countries to developed countries have caused the global pollution to rise drastically. The shifting of the burden therefore, is not the solution. Hence, an integrated well-devised global programme is imperative to tackle the alarming issue of the pollution and advanced countries should lead this programme.

Furthermore, FDI is believed to be an effective tool to generate employment and economic growth. The developing countries have been eager to attract FDI without having adequate property rights, clearly defined access status of the environmental resources and without any effective environmental management system. Therefore, there is a need to bring together concerned policies to manage the environmental resources in developing countries. The ASEAN countries would reap more benefit of FDI if it is directed to the services sector, high-tech industry and to energy-saving technologies.

Hence, the Government in the ASEAN countries should develop environmental management systems to attract inward FDI. They should strike a balance between development and environment. The ASEAN countries should actively introduce FDI to exploit the advanced clean technologies brought by foreign investors. They should strengthen the co-operation with advanced countries especially in low carbon-intensive industries. They should use foreign capital to promote industrial technology and efficiency in natural resources utilization.

The developing countries also lack the institutional capacity to make sound environmental policies. In more open economies, FDI and trade contribute to pollution levels as validated by the results of the current study. The developed countries, therefore, should assist developing countries by providing them with finance and technology in making sound environmental policies as the developed countries are ultimate users of the pollution-intensive goods. The current study does not raise any warning against globalization rather it recommends such environmental policies for poor nations that make them shift from technological limitations to those local skills where they have comparative advantages.

In addition, the pollution-intensive goods are resource intensive and developing countries have a comparative advantage in the production of these goods because environment resources are under-priced in developing countries. This result in distorted terms of trade between developed and developing countries. Therefore, pricing policies for environmental goods need to be further examined in developing countries. The real cost of environmental resources must be reflected in the price of the goods and services produced using these resources.

The environment is a common global responsibility of all states and non-state actors and developed and developing nations must make varying degrees of contribution towards current environment problems of the world. Each state has different capacities and interest to deal with the emerging environmental problems. Clapp (1998) pointed out that MNC and FDI had practised double standards especially in hazardous industries in developing countries. They have paid very little attention to transfer clean and most upgraded energy efficient technologies as it might had increased their cost of production. They rather had been most concerned with cleaning up process of the hazardous wastes. The moderate environment cost and low cost of production have been the major incentive for the developed countries to outsource the pollution-intensive production process. Such technologies help only to manage polluted and hazardous wastes of pollution-intensive industries rather than to curtail the pollution.

The developed states therefore, should bear the responsibilities in taking lead and assisting the developing countries to achieve the goals of sustainable development. The international communities should effectively cooperate and equitably democratize the responsibilities to do so. In recent years there has been increasing awareness among these nations that environment is a global problem that requires global co-operation. The international agreements on climate changes have developed from the stage of United Nations Framework Convention on Climate Change (1992) to the stage of Kyoto Protocol (1997) and to the stage of Paris agreement (2016).

There is also a need to expand the accounting regarding the embedded CO_2 emissions in the imports of advanced countries from developing world. The developed countries should offer the most up-graded technologies and energy efficient clean energies to developing countries. They should take care of technological changes for certain industries that are main source of the carbon embodied in imported manufactured products. Moreover, they should include as many countries as possible in the treatment of solving problems of trade and environmental quality.

The global warming, climate changes, depletion of natural resources and of ozone layer have become a reality and devastating impact of these changes on planet and on human life are well known now. The most important implication of our study is that these problems cannot be curtailed unless advanced countries do not curtail demand of pollution-intensive and environmental goods imported from developing countries. It is only possible if people from advanced world change their lifestyle. They must adopt a sustainable lifestyle[23] that can help to reduce their carbon footprint[24]. They must move to sustainable livings including more use of public transport, environmental friendly services and to reduce energy usages to contain the environmental impact of their consumption so that this planet may become clean, sustainable and safe for future generations. The further development can also be made by greening the bilateral, regional and international trade agreement like NAFTA and WTO. The developed countries are also in favour of the greening the WTO due to some pressure from the civil societies,

5.4 Limitations of the Study

The results and recommendations drawn from this research study have important reference for the policymakers in the ASEAN as well as in developing countries to devise policies to tackle the problem of environmental degradation. However, current study also having some limitations.

First, the study only evaluates the theory and assumption of the PHH on environmental problems of the ASEAN. Current study remains limited to the effect of the PHH on income environment relation in EKC framework. There are several other factors that have potential impact on income environment relations like energy intensities, energy efficiencies, governance, use of renewable energies, technological growth and public awareness about the

---

[23] "Sustainable living is a lifestyle that attempts to reduce an individual's or society's use of the Earth's natural resources and personal resources. Practitioners of sustainable living often attempt to reduce their carbon footprint by altering methods of transportation, energy consumption, and diet. Proponents of sustainable living aim to conduct their lives in ways that are consistent with sustainability, in natural balance and respectful of humanity's symbiotic relationship with the Earth's natural ecology and cycles. The practice and general philosophy of ecological living is highly interrelated with the overall principles of sustainable development."

[24] The total amount of greenhouse gases produced to directly and indirectly support human activities, usually expressed in equivalent tons of carbon dioxide (CO_2)

environmental issues. Due to limited time and resources, current study could not take up these issues.

Like other studies on environment, the current study also has faced the problem of data availability about the pollution. CO_2 is the only authentic and accessible data about the Green House Gases (GHG) for South and South East Asian countries. Considering the time and resource limitation, current study has utilized data on CO_2 on the assumption that it is strongly correlated with other local pollutants and a major contributor of environmental changes. There are other pollutants like SO_2, NOx, water pollution, loss of biodiversity, deforestation and so on. The information about these pollutants are not easily available. Although, some advanced countries have data about these pollutants, yet access to such information is very costly.

5.5 Suggestions for Further Research

The current research contributes to the existing body of the knowledge by opening new horizons for the future research. For instance, there is a need to evaluate the PHH within general equilibrium framework that consider the key sectors of the economy and the impact of the pollution on the economy and welfare of the people.

Different pollutants are more relevant in different countries depending upon the structure of an economy, therefore, further studies may be conducted to evaluate the PHH for different pollutants for different countries. There is also a need to investigate the impact of different pollutants generated from pollution-intensive industries on human life.

Moreover, current study is confined to assess the impact of exports of pollution-intensive goods on the slope of the EKC in developing countries. Further research therefore, can also be undertaken to investigate the impact of pollution-intensive imports on the EKC of advanced countries.

Furthermore, technological changes taking place in advanced countries have important bearings in determining the future of the environmental issues of the world. Changes in the way recycling are taking place and the reduction in the consumption of fossil fuels can have a profound effect on the level of pollution and on economic growth. Incorporating these aspects in the examining of the PHH will provide some new results and insights.

5.6 Conclusion of the Chapter

This chapter details the conclusion and policy recommendation of the research. First, a summary of the findings with respect to objectives of the study has been explained in Section 5.2. Second, policy recommendations based on the findings of the current study are detailed in Section 5.3. The limitations faced during the study are mentioned in the Section 5.4. Finally, the suggestions for further research are proposed in Section 5.5.

REFERENCE

Acharyya, J. (2009). FDI, growth and the environment: Evidence from India on CO2 emission during the last two decades. *Journal of economic development, 34*(1), 43.

Akbostanci, E., Tunc, G. I., & Türüt-Asik, S. (2007). Pollution haven hypothesis and the role of dirty industries in Turkey's exports. *Environment and Development Economics, 12*(02), 297-322.

Akbostancı, E., Türüt-Aşık, S., & Tunç, G. İ. (2009). The relationship between income and environment in Turkey: Is there an environmental Kuznets curve? *Energy Policy, 37*(3), 861-867.

Al-Mulali, U., Saboori, B., & Ozturk, I. (2015). Investigating the environmental Kuznets curve hypothesis in Vietnam. *Energy policy, 76*, 123-131.

Al-mulali, U., & Tang, C. F. (2013). Investigating the validity of pollution haven hypothesis in the gulf cooperation council (GCC) countries. *Energy Policy, 60*, 813-819.

Alam, M. M., Murad, M. W., Noman, A. H. M., & Ozturk, I. (2016). Relationships among carbon emissions, economic growth, energy consumption and population growth: Testing Environmental Kuznets Curve hypothesis for Brazil, China, India and Indonesia. *Ecological Indicators, 70*, 466-479.

Albornoz, F., Cole, M. A., Elliott, R. J., & Ercolani, M. G. (2009). In search of environmental spillovers. *The World Economy, 32*(1), 136-163.

Aliyu, M. A. (2005). *Foreign direct investment and the environment: Pollution haven hypothesis revisited.* Paper presented at the Eight Annual Conference on Global Economic Analysis, Lübeck, Germany.

Aller, C., Ductor, L., & Herrerias, M. J. (2015). The world trade network and the environment. *Energy Economics, 52*, 55-68.

Anderson, K., Blackhurst, R., & Secretariat, G. (1992). *The greening of world trade issues*: Harvester Wheatsheaf London.

Ang, J. B. (2007a). CO2 emissions, energy consumption, and output in France. *Energy Policy, 35*(10), 4772-4778.

Ang, J. B. (2007b). CO 2 emissions, energy consumption, and output in France. *Energy Policy, 35*(10), 4772-4778.

Apergis, N., & Ozturk, I. (2015). Testing environmental Kuznets curve hypothesis in Asian countries. *Ecological Indicators, 52*, 16-22.

Apergis, N., & Payne, J. E. (2009). CO 2 emissions, energy usage, and output in Central America. *Energy Policy, 37*(8), 3282-3286.

Asghari, M., & Mohamadi, M. H. (2016). Inter-Industrial Trade on Iran's Air Pollution. *Open Journal of Ecology, 6*(06), 277.

Aslanidis, N., & Iranzo, S. (2009). Environment and development: is there a Kuznets curve for CO2 emissions? *Applied Economics, 41*(6), 803-810.

Atici, C. (2009). Carbon emissions in Central and Eastern Europe: environmental Kuznets curve and implications for sustainable development. *Sustainable Development, 17*(3), 155-160.

Atici, C. (2012). Carbon emissions, trade liberalization, and the Japan–ASEAN interaction: A group-wise examination. *Journal of the Japanese and International Economies, 26*(1), 167-178.

Aubourg, R. W., Good, D. H., & Krutilla, K. (2008). Debt, democratization, and development in Latin America: How policy can affect global warming. *Journal of Policy Analysis and Management, 27*(1), 7-19.

Auci, S., & Becchetti, L. (2006). The instability of the adjusted and unadjusted environmental Kuznets curves. *Ecological Economics, 60*(1), 282-298.

Azhar, A., & Elliott, R. J. (2007). Trade and Specialisation in Pollution Intensive Industries: North–South Evidence. *International Economic Journal, 21*(3), 361-380.

Baek, J., & Koo, W. W. (2009). A dynamic approach to the FDI-environment nexus: the case of China and India. *Journal of International Economic Studies, 13*(2), 87-109.

Bartoszczuk, P., Ma, T., & Nakamori, Y. (2002). *Environmental Kuznets curve for some countries-regression and agent-based approach.* Paper presented at the AIR POLLUTION-INTERNATIONAL CONFERENCE-.

Becker, R., & Henderson, V. (2000). Effects of air quality regulations on polluting industries. *Journal of political Economy, 108*(2), 379-421.

Becker, R. A., & Tang, J. P. (2009). Pollution Havens and the Trade in Toxic Chemicals: Evidence from US Trade Flows. *Washington DC: US Bureau of the Census.*

Beghin, J., Dessus, S., Roland-Holst, D., & Van Der Mensbrugghe, D. (1997). The trade and environment nexus in Mexican agriculture. A general equilibrium analysis. *Agricultural Economics, 17*(2-3), 115-131.

Beladi, H., & Oladi, R. (2011). Does trade liberalization increase global pollution? *Resource and Energy Economics, 33*(1), 172-178.

Ben-Arye, E., Ali-Shtayeh, M. S., Nejmi, M., Schiff, E., Hassan, E., Mutafoglu, K., . . . Silbermman, M. (2012). Integrative oncology research in the Middle East: weaving traditional and complementary medicine in supportive care. *Supportive Care in Cancer, 20*(3), 557-564.

Blanco, L., Gonzalez, F., & Ruiz, I. (2013). The impact of FDI on CO2 emissions in Latin America. *Oxford Development Studies, 41*(1), 104-121.

Boamah, K. B., Du, J., Boamah, A. J., & Appiah, K. (2017). A study on the causal effect of urban population growth and international trade on environmental pollution: evidence from China. *Environmental Science and Pollution Research*, 1-13.

Bokpin, G. A. (2017). Foreign direct investment and environmental sustainability in Africa: The role of institutions and governance. *Research in International Business and Finance, 39*, 239-247.

Borhan, H., Ahmed, E. M., & Hitam, M. (2012). The impact of CO2 on economic growth in Asean 8. *Procedia-Social and Behavioral Sciences, 35*, 389-397.

Carvalho, T. S., & Almeida, E. (2009). The Global Environmental Kuznets Curve and the Kyoto Protocol. *CEP, 36036*, 330.

Caviglia-Harris, J. L., Chambers, D., & Kahn, J. R. (2009). Taking the "U" out of Kuznets: A comprehensive analysis of the EKC and environmental degradation. *Ecological Economics, 68*(4), 1149-1159.

Chakraborty, D., & Mukherjee, S. (2013). How do trade and investment flows affect environmental sustainability? Evidence from panel data. *Environmental Development, 6*, 34-47.

Chao, C.-C., & Eden, S. (2007). Trade liberalization, foreign ownership, and the environment in a small open economy. *International Review of Economics & Finance, 16*(4), 471-477.

Choumert, J., Motel, P. C., & Dakpo, H. K. (2013). Is the Environmental Kuznets Curve for deforestation a threatened theory? A meta-analysis of the literature. *Ecological Economics, 90*, 19-28.

Chow, G. C., & Li, J. (2014). Environmental Kuznets curve: Conclusive econometric evidence for CO2. *Pacific Economic Review, 19*(1), 1-7.

Clapp, J. (1998). Foreign direct investment in hazardous industries in developing countries: Rethinking the debate. *Environmental Politics, 7*(4), 92-113.

Cole, M. A. (1999). Limits to growth, sustainable development and environmental Kuznets curves: an examination of the environmental impact of economic development. *Sustainable Development, 7*(2), 87.

Cole, M. A. (2000). Trade liberalisation, economic growth and the environment. *Books*.

Cole, M. A. (2004). Trade, the pollution haven hypothesis and the environmental Kuznets curve: Examining the linkages. *Ecological Economics, 48*(1), 71-81.

Cole, M. A., & Elliott, R. J. (2003). Determining the trade–environment composition effect: the role of capital, labor and environmental regulations. *Journal of Environmental Economics and management, 46*(3), 363-383.

Cole, M. A., & Elliott, R. J. (2005). FDI and the capital intensity of "dirty" sectors: a missing piece of the pollution haven puzzle. *Review of Development Economics, 9*(4), 530-548.

Cole, M. A., Elliott, R. J., & Fredriksson, P. G. (2006). Endogenous pollution havens: Does FDI influence environmental regulations? *The Scandinavian Journal of Economics, 108*(1), 157-178.

Cole, M. A., Elliott, R. J., & Okubo, T. (2010). Trade, environmental regulations and industrial mobility: An industry-level study of Japan. *Ecological Economics, 69*(10), 1995-2002.

Coondoo, D., & Dinda, S. (2008). Carbon dioxide emission and income: A temporal analysis of cross-country distributional patterns. *Ecological Economics, 65*(2), 375-385.

Copeland, B. R., & Taylor, M. S. (1994). North-South trade and the environment. *The quarterly journal of Economics*, 755-787.

Costantini, V., & Mazzanti, M. (2012). On the green and innovative side of trade competitiveness? The impact of environmental policies and innovation on EU exports. *Research policy, 41*(1), 132-153.

Cox, A., Collins, A., Woods, L., & Ferguson, N. (2012). A household level environmental Kuznets curve? Some recent evidence on transport emissions and income. *Economics Letters, 115*(2), 187-189.

Dasgupta, S., Laplante, B., Wang, H., & Wheeler, D. (2002). Confronting the environmental Kuznets curve. *Journal of economic perspectives*, 147-168.

Davis, S. J., & Caldeira, K. (2010). Consumption-based accounting of CO2 emissions. *Proceedings of the National Academy of Sciences, 107*(12), 5687-5692.

De-yong, D. B.-s. S. (2008). A Research on the Relationship of Foreign Trade, FDI and Environment Pollution: 1995-2005 [J]. *Journal of International Trade, 4*, 18.

De Bruyn, S. M. (1997). Explaining the environmental Kuznets curve: structural change and international agreements in reducing sulphur emissions. *Environment and Development Economics, 2*(04), 485-503.

Dietzenbacher, E., & Mukhopadhyay, K. (2007). An empirical examination of the pollution haven hypothesis for India: towards a green Leontief paradox? *Environmental and Resource Economics, 36*(4), 427-449.

Dinçer, İ., & Rosen, M. A. (2010). Thermal energy storage (TES) methods. *Thermal Energy Storage: Systems and Applications, Second Edition*, 83-190.

Dinda, S. (2004). Environmental Kuznets curve hypothesis: a survey. *Ecological Economics, 49*(4), 431-455.

Du, H., Guo, J., Mao, G., Smith, A. M., Wang, X., & Wang, Y. (2011). CO 2 emissions embodied in China–US trade: Input–output analysis based on the emergy/dollar ratio. *Energy Policy, 39*(10), 5980-5987.

Ederington, J. (2007). NAFTA and the pollution haven hypothesis. *Policy Studies Journal, 35*(2), 239-244.

Egli, H. (2002). Are cross-country studies of the environmental Kuznets curve misleading? New Evidence from Time Series Data for Germany.

Elliott, R. J., & Shimamoto, K. (2008). Are ASEAN Countries Havens for Japanese Pollution-Intensive Industry? *The World Economy, 31*(2), 236-254.

Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: representation, estimation, and testing. *Econometrica: journal of the Econometric Society*, 251-276.

Eskeland, G., & Harrison, A. (1997). *Moving to Greener Pastures? Multinationals and the Pollution Haven Hypothesis. World Bank, Washington*. Retrieved from

Eskeland, G. S., & Harrison, A. E. (2003). Moving to greener pastures? Multinationals and the pollution haven hypothesis. *Journal of development economics, 70*(1), 1-23.

Esteve, V., & Tamarit, C. (2012). Threshold cointegration and nonlinear adjustment between CO 2 and income: the environmental Kuznets curve in Spain, 1857–2007. *Energy Economics, 34*(6), 2148-2156.

Esty, D. C. (1994). *Greening the GATT: Trade, environment, and the future*: Peterson Institute.

Esty, D. C. (2001). Bridging the trade-environment divide. *Journal of Economic Perspectives*, 113-130.

Ethier, W. J. (1982). National and international returns to scale in the modern theory of international trade. *The American Economic Review, 72*(3), 389-405.

Ezzati, M., Singer, B. H., & Kammen, D. M. (2001). Towards an integrated framework for development and environment policy: the dynamics of environmental Kuznets curves. *World Development, 29*(8), 1421-1434.

Farhani, S., Mrizak, S., Chaibi, A., & Rault, C. (2014). The environmental Kuznets curve and sustainability: A panel data analysis. *Energy Policy, 71*, 189-198.

FENG, X.-h., & LUO, Z.-c. (2016). Effect of Global Value Chain on Innovation Capability in China's High-tech Enterprises. *Journal of University of South China (Social Science Edition), 6*, 010.

Fisher, R. (1932). Statistical Methods for Research Workers (Edinburgh: Oliver and Boyd, 1925). *Google Scholar.*

Frankel, J. A. (2003). *The environment and globalization*. Retrieved from

Frankel, J. A., & Rose, A. K. (2005a). Is trade good or bad for the environment? Sorting out the causality. *Review of economics and statistics, 87*(1), 85-91.

Frankel, J. A., & Rose, A. K. (2005b). Is trade good or bad for the environment? Sorting out the causality. *The Review of economics and statistics, 87*(1), 85-91.

Galeotti, M., Lanza, A., & Pauli, F. (2006). Reassessing the environmental Kuznets curve for CO 2 emissions: a robustness exercise. *Ecological Economics, 57*(1), 152-163.

Galeotti, M., Manera, M., & Lanza, A. (2006). On the robustness of robustness checks of the environmental kuznets curve.

Galeotti, M., Manera, M., & Lanza, A. (2009). On the robustness of robustness checks of the environmental Kuznets curve hypothesis. *Environmental and Resource Economics, 42*(4), 551-574.

Gani, A. (2013). The effect of trade and institutions on pollution in the Arab countries. *Journal of International Trade Law and Policy, 12*(2), 154-168.

Gholipour Fereidouni, H. (2013). Foreign direct investments in real estate sector and CO2 emission: Evidence from emerging economies. *Management of Environmental Quality: An International Journal, 24*(4), 463-476.

Grossman, G. M., & Krueger, A. B. (1991). *Environmental impacts of a North American free trade agreement*. Retrieved from Cambridge:

Guo, J., Zou, L.-L., & Wei, Y.-M. (2010). Impact of inter-sectoral trade on national and global CO 2 emissions: an empirical analysis of China and US. *Energy Policy, 38*(3), 1389-1397.

Haisheng, Y., Jia, J., Yongzhang, Z., & Shugong, W. (2005). The impact on Environmental Kuznets Curve by trade and foreign direct investment in China. *Chinese Journal of Population Resources and Environment, 3*(2), 14-19.

Halicioglu, F. (2009a). An econometric study of CO2 emissions, energy consumption, income and foreign trade in Turkey. *Energy Policy, 37*(3), 1156-1164.

Halicioglu, F. (2009b). An econometric study of CO 2 emissions, energy consumption, income and foreign trade in Turkey. *Energy Policy, 37*(3), 1156-1164.

Halkos, G. E., & Tzeremes, N. G. (2009). Exploring the existence of Kuznets curve in countries' environmental efficiency using DEA window analysis. *Ecological Economics, 68*(7), 2168-2176.

Hao, Y., & Liu, Y.-M. (2015). Has the development of FDI and foreign trade contributed to China's CO2 emissions? An empirical study with provincial panel data. *Natural Hazards, 76*(2), 1079-1091.

Hassaballa, H. (2013). Environment and foreign direct investment: policy implications for developing countries. *Journal of Emerging Issues in Economics, Finance and Banking, 1*(2), 75-106.

He, J. (2006a). Pollution haven hypothesis and environmental impacts of foreign direct investment: The case of industrial emission of sulfur dioxide (SO2) in Chinese provinces. *Ecological economics, 60*(1), 228-245.

He, J. (2006b). Pollution haven hypothesis and environmental impacts of foreign direct investment: the case of industrial emission of sulfur dioxide (SO 2) in Chinese provinces. *Ecological Economics, 60*(1), 228-245.

He, J., & Richard, P. (2010). Environmental Kuznets curve for CO 2 in Canada. *Ecological Economics, 69*(5), 1083-1093.

He, J., & Wang, H. (2012). Economic structure, development policy and environmental quality: An empirical analysis of environmental Kuznets curves with Chinese municipal data. *Ecological Economics, 76*, 49-59.

Helpman, E. (1984). A simple theory of international trade with multinational corporations. *The journal of political economy*, 451-471.

Herzig, C., & Schaltegger, S. (2006). Corporate sustainability reporting. An overview *Sustainability accounting and reporting* (pp. 301-324): Springer.

Hettige, H., Mani, M., & Wheeler, D. (2000). Industrial pollution in economic development: the environmental Kuznets curve revisited. *Journal of Development Economics, 62*(2), 445-476.

Hoffmann, R., Lee, C. G., Ramasamy, B., & Yeung, M. (2005). FDI and pollution: a granger causality test using panel data. *Journal of international development, 17*(3), 311-317.

Honglei, C., Xiaorong, Z., & Qiufeng, C. (2011). Export-oriented Economy & Environmental Pollution in China: the Empirical Study by Simultaneous Equation Model. *Energy Procedia, 5*, 884-889.

Ibrahim, M. H., & Rizvi, S. A. R. (2015). Emissions and trade in Southeast and East Asian countries: a panel co-integration analysis. *International Journal of Climate Change Strategies and Management, 7*(4), 460-475.

Ibrahim, M. H., Rizvi, S. A. R., Leal-Filho, W., & Seixas, J. (2015). Emissions and trade in Southeast and East Asian countries: A panel co-integration analysis. *International Journal of Climate Change Strategies and Management, 7*(4).

Im, K. S., & Pesaran, M. H. (2003). On the panel unit root tests using nonlinear instrumental variables.

Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of econometrics, 115*(1), 53-74.

Iwami, T. (2001). Economic development and environment in Southeast Asia: an introductory note. *International Journal of Social Economics, 28*(8), 605-622.

Jaffe, A. B., Peterson, S. R., Portney, P. R., & Stavins, R. N. (1995). Environmental regulation and the competitiveness of US manufacturing: what does the evidence tell us? *Journal of Economic literature*, 132-163.

Jain, S., & Chaudhuri, T. D. (2009). The Environmental Kuznets Curve: A Reaffirmation. *ICFAI Journal of Environmental Economics, 7*(2).

Jänicke, M., & Weidner, H. (1997). *National environmental policies: a comparative study of capacity-building*: Springer-Verlag.

Jaunky, V. C. (2011). The CO 2 emissions-income nexus: evidence from rich countries. *Energy Policy, 39*(3), 1228-1240.

Javorcik, B. S., & Wei, S.-J. (2004). Pollution havens and foreign direct investment: dirty secret or popular myth? *Contributions in Economic Analysis & Policy, 3*(2).

Jebli, M. B., Youssef, S. B., & Ozturk, I. (2016). Testing environmental Kuznets curve hypothesis: The role of renewable and non-renewable energy consumption and trade in OECD countries. *Ecological Indicators, 60*, 824-831.

Jian, L., & Shanshan, Z. (2010). *Tianjin Eco-environmental Pressures and Economic Growth on the EKC Curve Analysis.* Paper presented at the Computing, Control and Industrial Engineering (CCIE), 2010 International Conference on.

Jobert, T., Karanfil, F., & Tykhonenko, A. (2014). Estimating country-specific environmental Kuznets curves from panel data: a Bayesian shrinkage approach. *Applied Economics, 46*(13), 1449-1464.

Johansen, S. (1995). *Likelihood-based inference in cointegrated vector autoregressive models*: Oxford University Press on Demand.

Johansen, S. (2002). A small sample correction for the test of cointegrating rank in the vector autoregressive model. *Econometrica, 70*(5), 1929-1961.

Johansson, P.-O., & Kriström, B. (2007). On a clear day you might see an environmental Kuznets curve. *Environmental and Resource Economics, 37*(1), 77-90.

Kanemoto, K., Moran, D., Lenzen, M., & Geschke, A. (2014). International trade undermines national emission reduction targets: New evidence from air pollution. *Global Environmental Change, 24*, 52-59.

Kao, C. (1999). Spurious regression and residual-based tests for cointegration in panel data. *Journal of econometrics, 90*(1), 1-44.

Kearsley, A., & Riddel, M. (2010). A further inquiry into the Pollution Haven Hypothesis and the Environmental Kuznets Curve. *Ecological Economics, 69*(4), 905-919.

Keho, Y. (2016). Do Foreign Direct Investment and Trade lead to Lower Energy Intensity? Evidence from Selected African Countries. *International Journal of Energy Economics and Policy, 6*(1).

Khanna, N., & Plassmann, F. (2004). The demand for environmental quality and the environmental Kuznets Curve hypothesis. *Ecological Economics, 51*(3), 225-236.

Kijima, M., Nishide, K., & Ohyama, A. (2010). Economic models for the environmental Kuznets curve: A survey. *Journal of Economic Dynamics and Control, 34*(7), 1187-1201.

Kiuila, O. (2015). Interactions between trade and environmental policies in the Czech Republic. *The Journal of International Trade & Economic Development, 24*(7), 1014-1035.

Kivyiro, P., & Arminen, H. (2014). Carbon dioxide emissions, energy consumption, economic growth, and foreign direct investment: Causality analysis for Sub-Saharan Africa. *Energy, 74*, 595-606.

Kolstad, C. D., & Xing, Y. (1998). Do Lax Environmental Regulations Attract Foreign Investment?

Kostakis, I., Lolos, S., & Sardianou, E. (2017). Foreign direct investment and environmental degradation: Further evidence from Brazil and Singapore. *Journal of Environmental Management & Tourism, 8*(1 (17)), 45.

Kumar, S., & Khanna, M. (2009). Measurement of environmental efficiency and productivity: a cross-country analysis. *Environment and Development Economics, 14*(04), 473-495.

Kunce, M., Gerking, S., & Morgan, W. (2002). Effects of environmental and land use regulation in the oil and gas industry using the Wyoming checkerboard as an experimental design. *American Economic Review, 92*(5), 1588-1593.

Kwiatkowski, D., Phillips, P. C., Schmidt, P., & Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root? *Journal of econometrics, 54*(1-3), 159-178.

Lan, J., Kakinaka, M., & Huang, X. (2012). Foreign direct investment, human capital and environmental pollution in China. *Environmental and Resource Economics, 51*(2), 255-275.

Lanoie, P., Laurent-Lucchetti, J., Johnstone, N., & Ambec, S. (2011). Environmental policy, innovation and performance: new insights on the Porter hypothesis. *Journal of Economics & Management Strategy, 20*(3), 803-842.

Lantz, V., & Feng, Q. (2006). Assessing income, population, and technology impacts on CO 2 emissions in Canada: Where's the EKC? *Ecological Economics, 57*(2), 229-238.

Lantz, V., & Martinez-Espineira, R. (2008). Testing the Environmental Kuznets Curve Hypothesis with Bird Populations as Habitat-Specific Environmental Indicators: Evidence from Canada. *Conservation Biology, 22*(2), 428-438.

Lee, C.-C., & Lee, J.-D. (2009). Income and CO 2 emissions: evidence from panel unit root and cointegration tests. *Energy Policy, 37*(2), 413-423.

Lee, C. G. (2009). Foreign direct investment, pollution and economic growth: evidence from Malaysia. *Applied Economics, 41*(13), 1709-1716.

Letchumanan, R., & Kodama, F. (2000). Reconciling the conflict between thepollution-haven'hypothesis and an emerging trajectory of international technology transfer. *Research policy, 29*(1), 59-79.

Levin, A., Lin, C.-F., & Chu, C.-S. J. (2002). Unit root tests in panel data: asymptotic and finite-sample properties. *Journal of econometrics, 108*(1), 1-24.

Levin, A., Lin, C.-F., & James Chu, C.-S. (2002). Unit root tests in panel data: asymptotic and finite-sample properties. *Journal of Econometrics, 108*(1), 1-24. doi:http://dx.doi.org/10.1016/S0304-4076(01)00098-7

Levinson, A. (1996). Environmental regulations and manufacturers' location choices: Evidence from the Census of Manufactures. *Journal of public Economics, 62*(1-2), 5-29.

Levinson, A., & Taylor, M. S. (2008). Unmasking the pollution haven effect. *International economic review, 49*(1), 223-254.

Li-yan, G. H.-y. H. (2008). Foreign Direct Investment, Environmental Regulation and Environmental Pollution [J]. *Journal of International Trade, 8*, 018.

Li, H., Grijalva, T., & Berrens, R. P. (2007). Economic growth and environmental quality: a meta-analysis of environmental Kuznets curve studies. *Economics Bulletin, 17*(5), 1-11.

Liang, F. H. (2008). Does foreign direct investment harm the host country's environment? Evidence from China.

Libo, W., & Chang, Y. (2017). The Difference of Environmental Effects between International Trade and Intranational Trade. *Journal of Environmental Economics, 2*, 003.

Lin, J., Pan, D., Davis, S. J., Zhang, Q., He, K., Wang, C., . . . Guan, D. (2014). China's international trade and air pollution in the United States. *Proceedings of the National Academy of Sciences, 111*(5), 1736-1741.

Lipford, J. W., & Yandle, B. (2010). Environmental Kuznets curves, carbon emissions, and public choice. *Environment and Development Economics, 15*(04), 417-438.

List, J. A. (2000). The effects of environmental regulations on foreign direct investment. *Journal of Environmental Economics and Management, 40*(1), 1-20.

List, J. A., & Co, C. Y. (2000). The effects of environmental regulations on foreign direct investment. *Journal of Environmental Economics and Management, 40*(1), 1-20.

Liu, L. (2008). Sustainability efforts in China: reflections on the environmental Kuznets curve through a locational evaluation of "Eco-Communities". *Annals of the Association of American Geographers, 98*(3), 604-629.

Lofdahl, C. L. (2002). *Environmental impacts of globalization and trade: A systems study*: MIT Press.

Lomborg, B. (2001). The skeptical environmentalist: Cambridge: Cambridge University Press.

López, L. A., Arce, G., & Zafrilla, J. E. (2013). Parcelling virtual carbon in the pollution haven hypothesis. *Energy Economics, 39*, 177-186.

Lopez, R. (1997). Environmental externalities in traditional agriculture and the impact of trade liberalization: the case of Ghana. *Journal of Development Economics, 53*(1), 17-39.

Low, P., & Yeats, A. (1992). Do" dirty" industries migrate? *World Bank Discussion Papers[WORLD BANK DISCUSSION PAPER.]. 1992.*

Mabey, N., & McNally, R. (1998). Foreign direct investment and the environment. *World Wildlife Foundation.*

MacDermott, R. J. (2008). Environmental Regulations and the Flow of Foreign Direct Investment: A Review of the Pollution Haven Hypothesis. *Foreign Direct Investment.*

Maclean, R. (2017). Chocolate industry drives rainforest disaster in Ivory Coast. Retrieved from https://www.theguardian.com/environment/2017/sep/13/chocolate-industry-drives-rainforest-disaster-in-ivory-coast

Maddala, G. S., & Kim, I.-M. (1998). *Unit roots, cointegration, and structural change*: Cambridge university press.

Maddala, G. S., & Wu, S. (1999). A comparative study of unit root tests with panel data and a new simple test. *Oxford Bulletin of Economics and statistics, 61*(S1), 631-652.

Mahmood, H., & Alkhateeb, T. T. Y. (2017). Trade and Environment Nexus in Saudi Arabia: An Environmental Kuznets Curve Hypothesis. *International Journal of Energy Economics and Policy,* 7(5), 291-295.

Managi, S., & Jena, P. R. (2008). Environmental productivity and Kuznets curve in India. *Ecological Economics, 65*(2), 432-440.

Mani, M., & Wheeler, D. (1998). In search of pollution havens? Dirty industry in the world economy, 1960 to 1995. *The Journal of Environment & Development,* 7(3), 215-247.

Markusen, J. R. (1984). Multinationals, multi-plant economies, and the gains from trade. *Journal of international economics, 16*(3), 205-226.

Martínez-Zarzoso, I., & Bengochea-Morancho, A. (2004). Pooled mean group estimation of an environmental Kuznets curve for CO 2. *Economics Letters, 82*(1), 121-126.

Masih, A. M. M., & De Mello, L. (2011). Does the 'Environmental Kuznets Curve'Exist? An Application of Long-run Structural Modelling to Saudi Arabia-La Curva di Kuznets esiste? Un'applicazione LRSM al caso dell'Arabia Saudita. *Economia Internazionale/International Economics, 64*(2), 211-235.

Mazzanti, M., Montini, A., & Zoboli, R. (2008). Municipal waste generation and socioeconomic drivers: evidence from comparing northern and southern Italy. *The Journal of Environment & Development.*

Mazzanti, M., Musolesi, A., & Zoboli, R. (2006). A Bayesian approach to the estimation of environmental Kuznets curves for CO2 emissions.

McCollough, J., He, M., & Bayramoglu, A. T. (2016). Pollution Havens and Their Relationship to the Environmental Kuznets Curve: The Case of the us Tyre Industry. *Economic Affairs, 36*(3), 258-272.

Meadows, D. H. (1972). Dennis l. Meadows, Jorgen Randers, William W. Behrens III.: THE LIMITS TO GROWTH. A Report to the Club of Rome: Universe Books, New York.

Merican, Y. (2007). Foreign direct investment and pollution in five Asean nations. *International Journal of Economics & Management, 1*(2), 245-261.

Millimet, D. L., & List, J. A. (2004). The case of the missing pollution haven hypothesis. *Journal of Regulatory Economics, 26*(3), 239-262.

Millimet, D. L., & Roy, J. (2015). Empirical tests of the pollution haven hypothesis when environmental regulation is endogenous. *Journal of Applied Econometrics.*

Mills, J. H., & Waite, T. A. (2009). Economic prosperity, biodiversity conservation, and the environmental Kuznets curve. *Ecological Economics, 68*(7), 2087-2095.

Minghua, L., & Yongzhong, Y. (2011). Environmental regulation and technology innovation: Evidence from China. *Energy Procedia, 5*, 572-576.

Mizgajski, J. T. (2013). CO2 embodied in trade between Poland and Selected Countries. *Journal of Economic Development, Environment and People, 2*(4), 48-60.

Moomaw, W. R., & Unruh, G. C. (1997). Are environmental Kuznets curves misleading us? The case of CO 2 emissions. *Environment and Development Economics, 2*(04), 451-463.

Muradian, R., & Martinez-Alier, J. (2001). Trade and the environment: from a 'Southern'perspective. *Ecological Economics, 36*(2), 281-297.

Naglis-Liepa, K. (2011). The environmetal kuznets curve hypothesis as theoretical aproach in renewable energy promotion in Latvia. *Management Theory and Studies for Rural Business and Infrastructure Development, 27*(3), 140-147.

Nahman, A., & Antrobus, G. (2005). The environmental Kuznets curve: a literature survey. *South African Journal of Economics, 73*(1), 105-120.

Neequaye, N. A., & Oladi, R. (2015). Environment, growth, and FDI revisited. *International Review of Economics & Finance, 39*, 47-56.

Nicholas, D. Z. a. (2015). Climate change and cities: a prime source of problems, yet key to a solution. Retrieved from https://www.theguardian.com/cities/2015/nov/17/cities-climate-change-problems-solution

O'Sullivan, M. (2017). High Consumption, Trade Shift Harmful Effects of Pollution. Retrieved from https://www.voanews.com/a/pollution-trade-study/3804203.html

Ogundipe, A. A., Alege, P. O., & Ogundipe, O. M. (2014). Income Heterogeneity and Environmental Kuznets Curve in Africa. *Journal of Sustainable Development, 7*(4).

Oita, A., Malik, A., Kanemoto, K., Geschke, A., Nishijima, S., & Lenzen, M. (2016). Substantial nitrogen pollution embedded in international trade. *Nature Geoscience, 9*(2), 111-115.

Panayotou, T. (1995). Environmental degradation at different stages of economic development. *Beyond Rio: The Environmental Crises and Sustainable Livelihoods in the Third World, Macmillan Press, London, UK.*

Panayotou, T. (2000). *Globalization and environment*. Retrieved from Cambridge, MA:

Pao, H.-T., & Tsai, C.-M. (2011). Multivariate Granger causality between CO 2 emissions, energy consumption, FDI (foreign direct investment) and GDP (gross domestic product): evidence from a panel of BRIC (Brazil, Russian Federation, India, and China) countries. *Energy, 36*(1), 685-693.

Pedroni, P. (1999a). Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and statistics, 61*(S1), 653-670.

Pedroni, P. (1999b). Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and statistics, 61*(s 1), 653-670.

Pedroni, P. (2001). Fully modified OLS for heterogeneous cointegrated panels *Nonstationary panels, panel cointegration, and dynamic panels* (pp. 93-130): Emerald Group Publishing Limited.

Pedroni, P. (2004). Panel cointegration: asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. *Econometric theory, 20*(3), 597-625.

Perkins, R., and E. Neumayer. (2005). International Technological Diffusion, Latecomer Advantage and Economic Globalization: A Multi-technology Analysis. *Annals of the American Association of Geographers,, 4*(95), 789–808.

Peters, G. P., & Hertwich, E. G. (2006). Pollution embodied in trade: The Norwegian case. *Global Environmental Change, 16*(4), 379-387.

Peters, G. P., Minx, J. C., Weber, C. L., & Edenhofer, O. (2011). Growth in emission transfers via international trade from 1990 to 2008. *Proceedings of the national academy of sciences, 108*(21), 8903-8908.

Plassmann, F., & Khanna, N. (2006). Preferences, technology, and the environment: understanding the environmental Kuznets curve hypothesis. *American Journal of Agricultural Economics, 88*(3), 632-643.

Poelhekke, S., & Ploeg, F. (2015). Green havens and pollution havens. *The World Economy, 38*(7), 1159-1178.

Porter, M. E., & Van der Linde, C. (1995). Toward a new conception of the environment-competitiveness relationship. *The journal of economic perspectives, 9*(4), 97-118.

Prakash, A., & Potoski, M. (2017). The EU effect: does trade with the EU reduce CO2 emissions in the developing world? *Environmental Politics, 26*(1), 27-48.

Puzon, K., & Alonzo, R. (2012). Re-examining the growth-emissions nexus: does the latecomer advantage alter the environmental Kuznets curve? *International Journal of Green Economics, 6*(3), 298-316.

Ramanathan, R. (2002). Combining indicators of energy consumption and CO2 emissions: a cross-country comparison. *International Journal of Global Energy Issues, 17*(3), 214-227.

Randerson, J. (2017). Rich countries owe poor a huge environmental debt. Retrieved from https://www.theguardian.com/science/2008/jan/21/environmental.debt1

Raspiller, S., & Riedinger, N. (2004). *Do environmental regulations influence the location behavior of French firms?* Retrieved from

Raymond, L. (2004). Economic growth as environmental policy? Reconsidering the Environmental Kuznets Curve. *Journal of Public Policy, 24*(03), 327-348.

Rehman, F. U., Nasir, M., & Kanwal, F. (2012). Nexus between corruption and regional Environmental Kuznets Curve: the case of South Asian countries. *Environment, Development and Sustainability, 14*(5), 827-841.

Ren, S., Yuan, B., Ma, X., & Chen, X. (2014). International trade, FDI (foreign direct investment) and embodied CO 2 emissions: a case study of Chinas industrial sectors. *China Economic Review, 28*, 123-134.

Rezza, A. A. (2013). FDI and pollution havens: Evidence from the Norwegian manufacturing sector. *Ecological Economics, 90*, 140-149.

Richmond, A. K., & Kaufmann, R. K. (2006). Is there a turning point in the relationship between income and energy use and/or carbon emissions? *Ecological Economics, 56*(2), 176-189.

Riti, J. S., Sentanu, I. G. E. P. S., Cai, A., & Sheikh, S. (2016). Foreign Direct Investment, Manufacturing Export and the Environment in Nigeria: A Test of Pollution Haven Hypothesis. *NIDA Development Journal: วารสาร พัฒนบริหารศาสตร์, 56*(2), 73-98.

Robalino-López, A., García-Ramos, J.-E., Golpe, A. A., & Mena-Nieto, Á. (2014). System dynamics modelling and the environmental Kuznets curve in Ecuador (1980–2025). *Energy Policy, 67*, 923-931.

Saboori, B., Sulaiman, J., & Mohd, S. (2012a). Economic growth and CO2 emissions in Malaysia: a cointegration analysis of the environmental Kuznets curve. *Energy policy, 51*, 184-191.

Saboori, B., Sulaiman, J., & Mohd, S. (2012b). Economic growth and CO 2 emissions in Malaysia: a cointegration analysis of the environmental Kuznets curve. *Energy Policy, 51*, 184-191.

Sánchez-Chóliz, J., & Duarte, R. (2004). CO 2 emissions embodied in international trade: evidence for Spain. *Energy Policy, 32*(18), 1999-2005.

Sapkota, P., & Bastola, U. (2017). Foreign direct investment, income, and environmental pollution in developing countries: Panel data analysis of Latin America. *Energy Economics, 64*, 206-212.

Sawhney, A., & Rastogi, R. (2015). Is India Specialising in Polluting Industries? Evidence from US-India Bilateral Trade. *The World Economy, 38*(2), 360-378.

Seker, F., Ertugrul, H. M., & Cetin, M. (2015). The impact of foreign direct investment on environmental quality: A bounds testing and causality analysis for Turkey. *Renewable and Sustainable Energy Reviews, 52*, 347-356.

Selden, T. M., & Song, D. (1994). Environmental quality and development: is there a Kuznets curve for air pollution emissions? *Journal of Environmental Economics and management, 27*(2), 147-162.

Shafik, N., & Bandyopadhyay, S. (1992). *Economic growth and environmental quality: time-series and cross-country evidence* (Vol. 904). The World Bank,

Washington, DC.: World Bank Publications.

Shahbaz, M., Nasreen, S., Abbas, F., & Anis, O. (2015). Does foreign direct investment impede environmental quality in high-, middle-, and low-income countries? *Energy Economics, 51*, 275-287.

Shao, Y., & Shao, Y. (2017). Does FDI affect carbon intensity? New evidence from dynamic panel analysis. *International Journal of Climate Change Strategies and Management*.

Shui, B., & Harriss, R. C. (2006). The role of CO 2 embodiment in US–China trade. *Energy Policy, 34*(18), 4063-4068.

Smarzynska, B. K., & Wei, S.-J. (2001). *Pollution havens and foreign direct investment: dirty secret or popular myth?* Retrieved from

Stern, D. I. (2004). The rise and fall of the environmental Kuznets curve. *World development, 32*(8), 1419-1439.

Stern, D. I. (2010). Between estimates of the environmental Kuznets curve.

Stern, D. I., & Common, M. S. (2001). Is there an environmental Kuznets curve for sulfur? *Journal of Environmental Economics and management, 41*(2), 162-178.

Stonehouse, D. P. (2000). A review of WTO and environmental issues. *Journal of Agricultural and Environmental Ethics, 13*(1), 121-144.

Sun, C., Zhang, F., & Xu, M. (2017). Investigation of pollution haven hypothesis for China: An ARDL approach with breakpoint unit root tests. *Journal of Cleaner Production.*

Tai, M.-Y., Chao, C.-C., & Hu, S.-W. (2015). Pollution, health and economic growth. *The North American Journal of Economics and Finance, 32*, 155-161.

Takeda, F., & Matsuura, K. (2006). Trade and the Environment in East Asia. *Korea and the World Economy, 7*(1), 33-56.

Tan, F., Lean, H. H., & Khan, H. (2014). Growth and environmental quality in Singapore: Is there any trade-off? *Ecological Indicators, 47*, 149-155.

Tan, H., Sun, A., & Lau, H. (2013). CO 2 embodiment in China–Australia trade: The drivers and implications. *Energy Policy, 61*, 1212-1220.

Tang, J. P. (2015). Pollution havens and the trade in toxic chemicals: Evidence from US trade flows. *Ecological Economics, 112*, 150-160.

Taskin, F., & Zaim, O. (2000). Searching for a Kuznets curve in environmental efficiency using kernel estimation. *Economics letters, 68*(2), 217-223.

Taylor, M. S. (2004). Unbundling the pollution haven hypothesis. *Advances in Economic Analysis & Policy, 3*(2).

Tobey, J. A. (1990). The effects of domestic environmental policies on patterns of world trade: an empirical test. *Kyklos, 43*(2), 191-209.

Van Beers, C., & Van Den Bergh, J. C. (1997). An empirical multi-country analysis of the impact of environmental regulations on foreign trade flows. *Kyklos, 50*(1), 29-46.

Wang, D. T., & Chen, W. Y. (2014). Foreign direct investment, institutional development, and environmental externalities: Evidence from China. *Journal of environmental management, 135*, 81-90.

Wang, K.-M. (2012). Modelling the nonlinear relationship between CO2 emissions from oil and economic growth. *Economic Modelling, 29*(5), 1537-1547.

Wang, Y., Kang, L., Wu, X., & Xiao, Y. (2013). Estimating the environmental Kuznets curve for ecological footprint at the global level: A spatial econometric approach. *Ecological indicators, 34*, 15-21.

Webber, D. J., & Allen, D. O. (2004). *Environmental Kuznets Curves: Mess or Meaning?* Retrieved from

WEN, H.-d., & LIU, Y.-l. (2008). An Empirical Study of Trade, FDI and Pollution Loss in China [J]. *Contemporary Finance & Economics, 5*, 018.

Westerlund, J. (2007). Testing for error correction in panel data*. *Oxford Bulletin of Economics and statistics, 69*(6), 709-748.

Wheeler, D. (2001). Racing to the bottom? Foreign investment and air pollution in developing countries. *The Journal of Environment & Development, 10*(3), 225-245.

Willis, A. (2003). The role of the global reporting initiative's sustainability reporting guidelines in the social screening of investments. *Journal of Business Ethics, 43*(3), 233-237.

Winslow, M. (2005). *The environmental Kuznets curve revisited once again.* Paper presented at the Forum for Social Economics.

Xiaoling, Y. W. Y. (2008). The Effect of Foreign Trade and FDI on Environmental Pollution: An analysis based on the Impulse Response Function of Time Series in China: 1982~2006 [J]. *World Economy Study, 12*, 012.

Xing, Y., & Kolstad, C. D. (2002). Do lax environmental regulations attract foreign investment? *Environmental and Resource Economics, 21*(1), 1-22.

Xinlian, Z., Jiwen, W., & Dengshan, T. (2010). *Study on Existence of EKC in China Employing Hierarchical Cluster Method.* Paper presented at the E-Product E-Service and E-Entertainment (ICEEE), 2010 International Conference on.

Xiqin, H., Hai, Z., & Li, Y. (2006). Resolving Trade and Environment Conflicts: A Focus on Sustainable Trade in China. *Chinese Journal of Population Resources and Environment, 4*(2), 55-60.

Xu, X. (2000). International trade and environmental regulation: time series evidence and cross section test. *Environmental and Resource Economics, 17*(3), 233-257.

Yang, H.-Y. (2001). Trade liberalization and pollution: a general equilibrium analysis of carbon dioxide emissions in Taiwan. *Economic Modelling, 18*(3), 435-454.

Yavuz, N. Ç. (2014). CO2 Emission, Energy Consumption, and Economic Growth for Turkey: Evidence from a Cointegration Test With a Structural Break. *Energy Sources, Part B: Economics, Planning, and Policy, 9*(3), 229-235.

Yunfeng, Y., & Laike, Y. (2010). China's foreign trade and climate change: a case study of CO 2 emissions. *Energy Policy, 38*(1), 350-356.

Zanin, L., & Marra, G. (2012). Assessing the functional relationship between CO 2 emissions and economic development using an additive mixed model approach. *Economic Modelling, 29*(4), 1328-1337.

Zarsky, L. (1999). Havens, halos and spaghetti: untangling the evidence about foreign direct investment and the environment. *Foreign direct Investment and the Environment, 13*(8), 47-74.

Zhang, Q., Jiang, X., Tong, D., Davis, S. J., Zhao, H., Geng, G., . . . Streets, D. G. (2017). Transboundary health impacts of transported global air pollution and international trade. *Nature, 543*(7647), 705-709.

Zhao, Y., Wang, S., Zhang, Z., Liu, Y., & Ahmad, A. (2016). Driving factors of carbon emissions embodied in China–US trade: a structural decomposition analysis. *Journal of Cleaner Production, 131*, 678-689.

Zilio, M. I. (2012). Curva de Kuznets ambiental: La validez de sus fundamentos en países en desarrollo. *Cuadernos de Economía, 35*(97), 43-54.